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The illustrations show the following :—

1, 2 & 3. **METALASTIK VEE-TYPE COUPLINGS:** a most successful type of coupling transmitting torque through rubber loaded in shear. Will absorb shocks and damp out vibrations, possesses high torsional flexibility, and accommodates shaft misalignment. The metal parts of Fig. 1 type can be bored and keyed for fitting directly on the shafts.

4 & 5. **METALASTIK ULTRA-DUTY BUSH COUPLINGS :** especially suitable for high-speed operation. The design permits a high degree of torsional flexibility and provides for shock loads, vibration and conical misalignment of the shafts. For greater flexibility and a larger degree of misalignment, these couplings can be used in series with a light shaft connecting two couplings, as Fig. 4.

6. **METALASTIK "ROTOFLEX" COUPLINGS:** provide considerable torsional flexibility, accommodate angular misalignment and a large extent of end float; they are particularly suited for cardan shaft assemblies. For high-speed operation a special centring device is used.

7. **METALASTIK UNIVERSAL COUPLINGS:** have considerable torque capacity and little torsional flexibility but will accommodate angular misalignment with very low resistance.

8. **METALASTIK DOUBLE-CONE COUPLINGS:** have a very high torque capacity and in other respects are similar to the Ultra-Duty bush coupling. End thrust can also be carried by these couplings and they are therefore particularly suitable for marine propulsion.

9. **METALASTIK TRAILING-LINK COUPLINGS:** accommodate considerable parallel misalignment as well as end-float and conical misalignment, and a single unit therefore replaces a long cardan shaft assembly.

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METALASTIK

What do the Stars Foretell?

THERE are different ideas in the world today on how to occupy the time and energies of expanding populations. Different, that is, politically, but not very different practically. The practical object is everywhere pretty much the same—more food, more goods of every kind, more electricity. Present-day knowledge of medicine and hygiene and of the various technologies are what make this possible. Without the new medical knowledge populations would not expand as they are doing, and without the technological knowledge there would not be either the quantity or variety of products. The general level of activity in these directions is everywhere high, but not as high as it was a year or two ago and the difference is enough to be called a slump, as it must be as soon as the willing are unable to find work. To re-employ them requires first the means and the trade, with the certain knowledge that their purchasing power will contribute to sustaining the economy. Within a closed circuit these circumstances are controllable, but where to find a closed circuit? There seems to be no country that is entirely self-sufficient—even Russia has been trying to sell tinned crab to the United States. There is opportunity where there are expansive influences, but only while the influences last. A change in technique, like the introduction of a radically new system of transport, has this effect; so has the emergence into prosperous activity of a hitherto backward and undeveloped country, but as soon as the country becomes industrially established its problems take on a different form if they are not augmented by new ones. This is not a disadvantage. Man has a fighting instinct and a problem or a difficulty is a challenge which it is normal in his nature to accept and overcome. Most of these challenges are of his own making in that they arise out of his activities, in ignorance of or without thought for the implications. He has better health and more prosperity than ever before, but he is not certain about his wisdom. A slump has descended upon world trade and there is no quick and flexible shift of activity to overcome it; no feedback to detect the change at its inception and enable a correction to be injected. The depression has to become severe before it becomes real, and then it is a case of repairing the damage. The injection is delayed; but nowadays it is used. Almost right up to the last war it was practically unknown, and wars persisted throughout history as did booms and slumps—right from the time when the primitive tribe, having gathered in the harvest, went out to forage and pillage.

What did a war do in the past that could not be done now and in the future peaceably by consciously directed effort? Nothing in the light of present knowledge. War has stimulated invention, discovery and development because the means and opportunity were provided of necessity. The big change in recent times is that both continue to be provided long after the fighting has finished. There is still the driving force of necessity but it is without active destruction. The Russians are spending about 1% of their income on rocket development and the Americans are investing heavily in the same way. The rockets are still primarily military missiles and if it were not for the moon they might now be firing them at each other, but with the moon to reach first and so much else to add to pride and prestige still further away their missiles are on the point of becoming space ships and their warheads propelling engines. Let it continue and become the sport of nations. It has sometimes looked as though human economy can only be balanced by a non-profit earning expenditure: if this is so it is much better that it should be for the adventure of fundamental research than for the misfortune of mutual destruction.

LOG SHEET

Designing by Computor

With the aid of an electronic computor, the detailed design calculations for a power station floor structure recently took two hours of computor time. A design engineer would have taken several weeks to complete a similar task. This is one recent example of the speeding up of structural steelwork design which has been achieved by United Steel Structural Company, Limited, Scunthorpe, working in collaboration with the department of operational research and cybernetics of The United Steel Companies, Limited, Sheffield.

Many large buildings today have precast, reinforced concrete floors, supported on a steel framework. Working from the architects' plans for the building, the structural engineer has to select the lightest and most economical section for each beam in the framework from among the standard steel sections which are available to him. This entails four different sets of stress calculations for each beam; if a section is not satisfactory by all four tests, then the next size larger is investigated until one is found to meet the conditions. A similar process is repeated for every beam in the structure.

Devising a computor programme

Although involving much routine work, accuracy is of paramount importance in these calculations and they cannot, therefore, be left safely to junior staff. The main problem in adapting the work to automatic computation lay in devising a computor programme which would translate the geometry of the design—the positions of all walls, points loads and supporting columns, and the positions and amounts of distributed loads—into a numerical form that completely described a structure. A computor can only accept numerical (or digital) information and it is only as numbers and letters that this information can be easily transcribed to teleprinter tape. This difficulty was overcome partly by employing a reference grid, with two co-ordinates to describe each point of interest in the floor.

At certain stages in floor design, however, it is necessary to scan neighbouring regions of the floor space in order to decide how much of the distributed load must be allocated to certain beams. So that the computor can accomplish this operation, the reference grid is treated as being uniformly spaced in either direction, regardless of the actual intervals between successive grid lines. Instead of distances, only the numbers of the grid lines need be quoted. For each intersection in the grid, there is a block of information space allocated in the computor's store. Here, the computor stores away all the information it receives about the beams passing through each intersection and about the nature of the floor in all directions in the immediate vicinity. Scanning from one point to a neighbouring one on the floor thus becomes a matter of systematic movement from one store to the next in the computor. When actual distances are required, they are found by reference to a list of the grid lines.

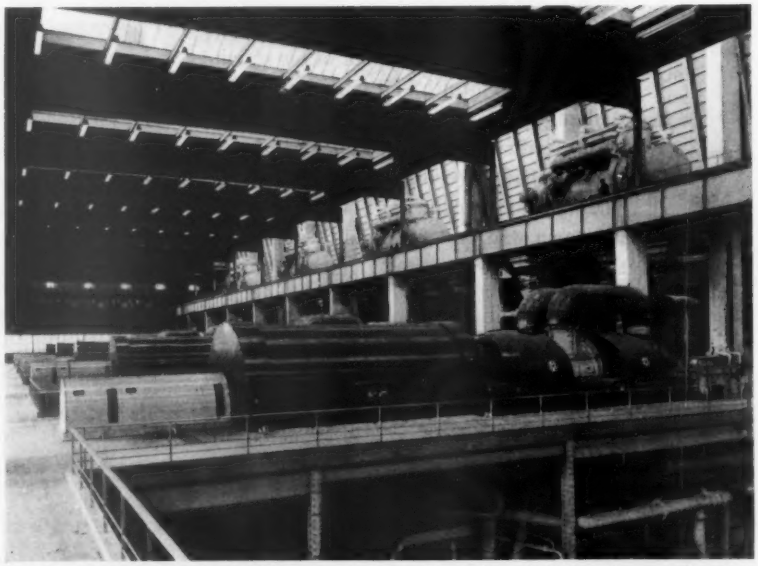
As computation proceeds, the information in each block is progressively amended as the reactions of one beam on another are calculated in turn and as suitable sections are selected for each beam.

Conversion of a floor plan into numerical form is a matter of simple routine, the data being transcribed to paper tape by a typist using a teleprinter. This punched tape provides a complete description of the floor framework to be designed, code letters indicating to the computor the meanings to be attached to the various groups of information. The programme examines and sorts this data into its grid form, apportions the floor loadings to the appropriate beams, and then proceeds to calculate the beams required. As soon as any one beam has been designed, the results are immediately punched out on paper tape for transmission by teleprinter while the computor is working on the next beam.

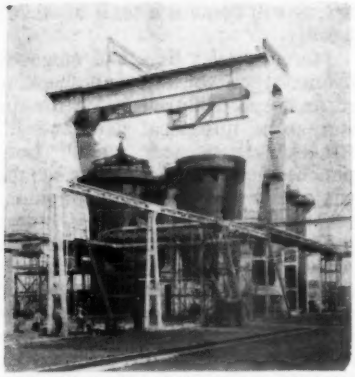
Wide Aluminium Plate

The application of aluminium plate has been limited in the past by the small sizes which were available, the maximum width available in this country hitherto being approximately 7 ft. New rolling mill plant will eventually produce wider plate at Rogerstone, but in the meantime the Northern Aluminium Company Limited have successfully developed automatic welding of aluminium plate to give sizes up to 30 ft by 11 ft on a production basis.

Noral plate in thicknesses up to 0·4 in. is butt-welded by means of a type C Argonaut head mounted on



CASTLE DONINGTON POWER STATION.—The Metropolitan-Vickers 100-MW turbine-generator sets at the Castle Donington power station of the Central Electricity Generating Board. Six of these sets were ordered and five are at present installed. The two-cylinder turbines run at 3000 rpm and the inlet steam is at 1500 psig and 1050° F. The generator voltage is 13·8 kV; the generators being hydrogen cooled. The relatively low overall length of the set of 80 ft has been achieved by the use of a rigid coupling between the high-pressure and low-pressure rotors, with only one central bearing and a single thrust block to locate the combined rotor



GOLIATH CRANE.—This 50 ton welded box electric travelling Goliath crane has been delivered to the new South East Gas Board Works in the Isle of Grain, which is being constructed to convert waste gas from the B.P. Isle of Grain Refinery. Ordered by Newton Chambers & Company Limited, the crane was designed and built by J. H. Carruthers & Company Limited, of Glasgow. It is unusual in that it is the first welded box crane commissioned by the South East Gas Board. The welded box construction is simple to maintain, is rigid, and cheaper than lattice construction and repainting is cheaper and simpler. The Lancashire Dynamo and Crypto Limited motors are one hour rated slip ring type. Allen West & Company Limited, contractor gear is fitted to hoist and travel motions and is operated by master controllers. Brakes are by Elliston Evans & Jackson Limited, and are electro magnetic for hoist and cross-traverse motions, and electro hydraulic for long travel. The aluminium sheathing over the cab was supplied and fitted by Freeman Morrison & Company. The crane is so quiet in operation that alarm bells are being fitted to avoid accidents

a motorized tractor supplied by British Oxygen Gases Limited. A welding jig holds the two plates flat with the required welding gap and the self-propelled carriage moves along the seam at speeds of between 15 and 150 in. per min. The process is said to give consistently sound results and complete freedom from distortion.

After completion of the weld, which is made in one pass, the top weld bead is removed by grinding flush. The plate is then lifted from the welding jig by crane, reversed by turn-over mechanism and the penetration bead removed by grinding. A single panel at one end of the base houses the controls for the jig and turn-over mechanism and the main controls for the welding carriage. A CDR600 rectifier power unit supplies the welding current.

As the weld bead is ground flush, this wide plate is comparable in appearance with normal rolled material. Because the weld is made under carefully controlled conditions its strength is higher than can be ensured by welding during subsequent fabrication under site condition.

The following are typical properties across the weld, in plate to specification BS 1476:NP5/6, an alloy frequently chosen for welded aluminium plate work.

0·1% proof stress of 8 tons/sq in. which is the same as the minimum demanded for unwelded material by this specification.

Ultimate tensile strength of 16·3 tons/sq in. compared with 17 tons/sq in. specified.

Elongated 11% compared with 12% specified.

Electronic Wheel Trueing

The only electronic wheel trueing machine in the world is used by Phillips Cycles Limited. It was designed by The British Cycle Corporation Limited in conjunction with Tube Investments Technological Centre and turns out wheels that are completely true and free from any irregularities. The wheel, roughly laced but with the spokes still loose, is placed in the machine by the operator, who then merely

Electronically controlled machine for automatically trueing cycle wheels. Forty motors adjust the spokes in accordance with "instructions" delivered by a sensing head rotating around the rim

presses a button and takes no further part in the operation until the machine has finished trueing and testing the wheel one minute later.

When the wheel is placed in the machine it is automatically lowered horizontally into a bed incorporating a ring of 40 electric motors, each of which is individually controlled, each one tightening one spoke only. When the spoke nipples have been gripped by the spanners driven by these electric motors, a magnetic sensing head is lowered on the end of an arm which is then rotated at high speed just above the rim of the wheel—the head scanning the rim all the time to detect any divergence from the true circle.

The information from this inductive magnetic head is fed into two control cubicles at the rear of the machine, where it is translated by electronic devices into individual "instructions" for each one of the 40 electric motors tightening the spokes.

The machine is so designed that the only forces acting on the rim are those imposed by the spokes themselves, so that when the wheel is true in the machine it will stay true when removed from it.

The spokes are tightened until there is the correct overall tension and when the trueing is completed the magnetic inductive head continues to rotate as a final check that the operation is completed. When it is satisfied that each spoke is under the right tension the rotation stops and the sensing head is withdrawn. The spanners then rotate slightly to free the spokes, and the wheel is released and ready for the operator to remove it.

The operations are, in fact, rather more complex than has been suggested in this brief outline, as the variations in dimensions of the rims are such that the machine has to determine its own tensioning limits before trueing can start. Nevertheless, it still trues and tests at the rate of one wheel per minute, the wheel being true to within 0·030 in. This is a much faster rate of production and a greater degree of accuracy than could be achieved by even the most skilled wheel builder.

Lurgi Gasification Plant

The first Lurgi pressure-gasification plant in Britain is to be built on the Scottish Gas Board's site at Westfield on the border of Fife and Kinross-shire. It will be built by Humphreys and Glasgow Limited at a cost of £6,600,000. Concurrently a high-pressure and medium-pressure grid system will be laid to distribute the gas over an area extending from the counties of Perth and Angus in the north-east, and through the counties of Kinross, Fife and Stirling, to Lanarkshire in the south-west and to the Lothians. The total cost of the plant and the associated grid system will be nearly £8,500,000.

The Lurgi process makes gas and by-products from large quantities of unwashed low-grade coal which have hitherto been virtually unusable. The plant will consume 350,000 tons of poor-quality opencast coal a year; if

the same quantity of gas were made in orthodox carbonizing plant, well over 400,000 tons of good-quality deep-mined coal would be required.

All the carbon in the coal used is converted into gas, tar, ammonia and benzole. The residue is purely ash. The gas will be produced at such high pressure that it can be readily distributed over distances without installing compressors.

In association with the building of the Lurgi plant, The Scottish Gas Board are constructing a 133-mile grid system. A total length of 75 miles of 12 in. steel pipe-line will be laid to carry gas from Westfield to Coatbridge in the west and Dundee in the north. A further 58 miles of steel branch lines ranging from 8 in. to 3 in. dia will supply individual undertakings and local grid systems. The technique of pipe-line construction employed is that developed for long-distance cross-country oil pipe-line and natural-gas transmission lines in America and the Middle East.

The Lurgi plant does not produce coke, and the demand for good-quality coke and prepared fuels is bound to increase as the Clean Air Act is more and more widely implemented. Thus, whilst according to the policy which The Scottish Gas Board have consistently followed in the past, small and uneconomic undertakings in the grid area will be progressively integrated, many of the remaining manufacturing units will probably continue in operation to produce prepared smokeless fuels and to act as "stand-by" for periods during which the Lurgi plant is not in full production.

The creation of an extensive and flexible distribution system means continuity of a guaranteed supply of gas at all times. If, for example, the demands of Angus and Fife could not be met by the Lurgi plant and other local manufacturing centres, the new grid would enable consumers to be supplied from the coke-ovens of Lanarkshire, or any of the large gas-manufacturing centres in the west. Equally, supplies for the Glasgow area could, if need arose, be obtained from the new plant in Fife. In this way the Lurgi plant will ultimately be integrated into the overall pattern of gas production.

ACE Computor

One of the world's largest and fastest electronic computing machines —the one known as ACE—is in operation at the National Physical Laboratory. It is the end-product of research which began at the end of the war and is successor to a pilot-model of one-sixth of the size of the new machine.

The numbers and instructions have 48 binary digits (equivalent to 14 decimal digits). The working store consists of 800 words, and the backing store of four magnetic drums will contain a total of 32,768 words.

Mercury delay lines and magnetic drums (the working and backing stores respectively) are used for the storage of numerical data and instruction sequences, and both punched card and magnetic tape equipment are provided for input and output.

The compact control desk has some 160 keys and 300 signal lamps, in addition to audible and visual displays of the computation. Nevertheless, most computations are carried out entirely by pushing one key—marked "Initial Input". This key causes punched cards to be read, which tell ACE what to do.

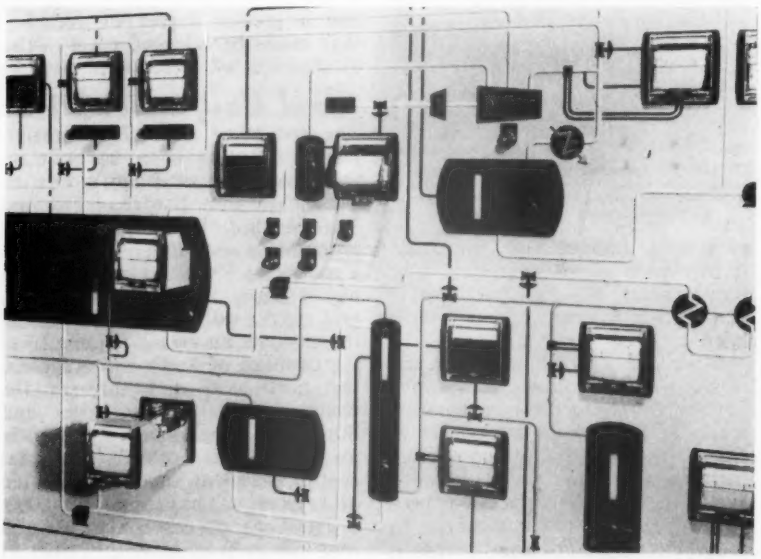
The most interesting mechanical assemblies in ACE are the four magnetic drums, entirely designed and constructed at N.P.L. The drums rotate at 12,000 rpm so accurately that the arrival at a given point of a magnetic spot one hundredth of an inch in length, travelling at 200 miles per hour, is timed to a millionth of a second. The drums have unique rapidly moving recording heads and are only a part of the number store or "memory" of ACE. An idea of the speed of ACE can be gained from the fact that these drums are the slowest part of its number store.

ACE incorporates many unique design features. The operating "mechanism" consists of about 6,000 miniature electronic valves, arranged in an impressive array of 10 large cabinets. Each cabinet is fitted with an electrically operated rising door to give rapid access for fault finding. It has a cooling system of circulating air, with heat exchangers and a water cooler.

ACE has three forms of storage. The largest part of the store consists of the four magnetic drums which store a total of 32,768 numbers. The access to these numbers is limited by the need to wait for the drum to revolve, and may take up to seven milliseconds. These drums are used by the computor for the large mass of data that it may not want quickly.

For more rapid access, a mercury delay line store of 768 numbers is employed. The time required for access to these is up to one thousandth of a second. This store is used for the programme, but instructions are stored in such a way that no time is wasted in waiting for them.

The most rapid access store consists of short delay lines storing one, two or four numbers each. These



CENTRALIZED CONTROL SYSTEM.—Part of a graphic panel recently completed at the new Redhill factory of Foxboro-Yoxall Limited and illustrating the use of the compact Consotrol instruments. Included are pull-out recorder controllers, indicators, ribbon indicators, switch and regulator sub-panels and various signal lights and cancellation buttons. Two of the pull-out recorder controllers are shown partially withdrawn on the left. Both electric and pneumatic connexions are of the plug-in type and when the unit is withdrawn from the panel a series of air check valves automatically closes to prevent loss of pressure in the impluse lines

are used for the small group of numbers that the computor is using for a short while.

By good programming, the full advantages of the large store can be enjoyed, with a time of access not much greater than is given by the short delay lines.

The ACE instructions specify the addresses—the locations in the store—of two numbers to be operated on, the operation, and the addresses of the desired destination of the result and the location of the next instruction. Thus four addresses are used, and all four accesses occur nearly simultaneously. In addition, multiplication and division occur in separate, autonomous devices, so that they can occur simultaneously with other operations.

In many cases, the computor will average 15,000 operations per second, each involving the extraction of two operands (numbers to be operated on), storing the result and extracting the next instruction.

Input and output is by punched cards. Magnetic tapes will be fitted later, but will be used as an extension to the store. The input speed from cards will be 7000 binary digits per second, with a rate of 450 cards per minute punched in binary.

Push-button Phone Switching

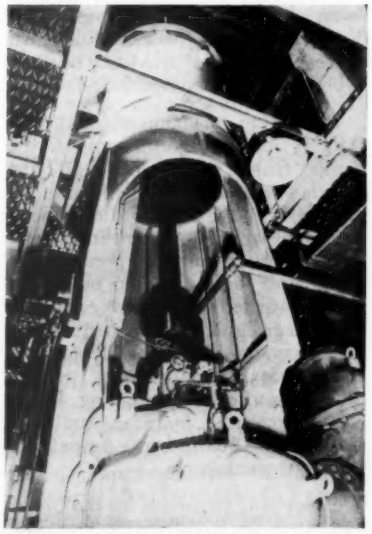
The first cordless switchboard to receive Post Office sanction is at the European headquarters of the Canadian Pacific Railway Company in Trafalgar Square, London. It controls a private automatic branch exchange, manufactured by Automatic Telephone & Electric Company Limited, and instead of the jacks, plugs and cords of the conventional switchboard there are rows of push-buttons and keys, mounted on a small desk, smartly styled in light oak with grey panelling. The familiar dial is only there for stand-by use, because dialling has been replaced by the much faster system known as key-sending, which the operator (not the extensions) uses for calling both internal and external numbers. The exchange has 110 extensions, 29 lines to the public exchange and four private wires to other offices.

A system of lamps tells the operator how many calls are waiting. To accept a call, the operator simply moves a key (the waiting calls are automatically brought up in rotation) and sets up the number of the required extension by pressing the appropriate push-buttons. The operator then presses the "Send" key, the extension is rung automatically and a lamp indicates "free" or "busy". If the line is free, the outside call is put through automatically. If busy, a "Ring When Free" facility can be used. This device rings the extension when it becomes free and automatically connects the outside call. Sometimes the operator will wish to advise a "busy" extension that an important outside call is waiting; this can be done by transmitting a warning tone. When the required extension hangs up he is automatically rung and, on answering, is connected to the incoming call.

An extension can "hold" an outside call while he makes an internal call; he can automatically transfer an outside call to another extension, without help from the operator; and if perhaps he is not sure to which extension the call should be transferred, he can return it to the operator for action.

Shaft Sinking Record

For the record-breaking shaft-sinking at the N.C.B. Parkside Colliery, near Newton-le-Willows in Lancashire the contractors, Kinnear Moodie & Co. Limited, used mining methods based on modern South African practice introduced to this country by arrangement with Roberts Construction Company Limited, Johannesburg. For drilling the rock prior to blasting, Holman Silver Three rock drills were used by three shifts working seven days a week, and a Cactus grab on a mono-rail was used for removing the spoil. During the months of June and July each of two shafts were sunk more than 500 ft. The work is due for completion early next year.



COOLING WATER PUMPS.—The new Rolls-Royce plant at Derby for testing high altitude aero engines requires a large volume of cooling water which is supplied by three Sigmund pumps each of 10,000 gpm capacity against a total head of 110 ft. Each unit is provided with a vertical spindle electric motor developing 450 hp running at 975 rpm and operating from a high tension supply of 6600 volts, 3 phase, 50 cycles; the motors being of squirrel cage type, arranged with direct across-the-line starting. The pumps have 24 in. dia suction and 20 in. dia delivery branches; each unit being independently self-supporting with the motor mounted on a distance piece to raise it to the necessary height, and being completely independent of the motor room flooring. The motors have thrust bearings to support the intermediate shafting, the rotating parts of the pump and any out-of-balance hydraulic thrust

Precision Rolled Rings

This new ring rolling mill at the Netherton works of N. Hingley & Sons Limited will make light section rings up to 72 in. dia in a range of non-ferrous metals including the Nimonic series and titanium. Rings are also made in stainless steels as well as other alloy and carbon steels. The rings are required to conform to very fine limits of dimensional accuracy and also be uniform in section and flatness.

The new mill is fed with punched blanks. It is electrically driven and the arrangement of rolls and positioning devices ensures that each blank is subjected to evenly distributed and uniform pressure applied hydraulically to expand the blank into the required ring form; the grain flow round the ring, a most important factor, is also uniform.

These rings are used for a great range of engineering components. Examples are their use in aircraft engines, guided missiles, nuclear energy plant, ships engines and in the various types of power units which are being used in the new railway locomotives.

Pulp Mill Plant

The new pulp mill at Sudbrook Pulp Mill Limited, Monmouthshire, a new subsidiary of the Wiggins Teape Group, is the first in Britain capable of producing wood pulp for papermaking from home grown hardwoods by the neutral sodium sulphite process. It will eventually have an output of 25,000 tons of "Gatecel" moist bleached pulp per annum for which some 70,000 tons of greenwood (or 5 million logs, each 4 ft long) will have to be handled. Construction cost of the new mill was over £1,000,000.

The pulping process is entirely

automatic and is controlled by one man at a central instrument panel. Indicator lamps are mounted on a diagrammatic flowsheet in the control room and they, together with the recording and other instruments, give complete information on the state of the process.

Normally the mill is in operation 24 hours a day, 7 days a week, stopping only for maintenance shut-down periods. These continuous operating conditions demand an extremely high degree of reliability and efficiency from all components of the pulping process—especially the electrical drives for pumps and conveyors, the latter being used throughout the whole plant to the extent of over 1,000 ft of conveyor belting and nearly 300 ft of roller and chain conveyors.

The majority of the motors in the mill are of the squirrel cage totally enclosed, Crompton Parkinson fan cooled "KLOSD" type, ranging in size from 2 to 150 hp. David Brown Radicon reduction gears are fitted to most of the drives. Drive circuits are mainly of the sequence interlocking type in order to ensure that logs or wood chips are never fed into a machine or on to a conveyor which is not moving.

Basically the pulping process is as follows: after being weighed and inspected twice for size, straightness, fungus growth, species and age, acceptable logs are transferred from a 100 ft flat belt conveyor to chain conveyors which transport the logs, one by one, to a de-barking machine wherein the bark is removed by rotary cutters. Logs undergo two stages of de-barking so that no traces of bark remain to spoil the pulp. The de-barked logs then pass along another chain conveyor to the chipper building.

In the chipper building the logs are carried, via conveyors, to the top of a chute on a chipping machine. After falling down the chute, a 4 ft log of 6 in. dia is reduced to 24,000 chips, about $\frac{3}{4}$ in. long, in one second. About 2,500,000 chips are needed for one ton of pulp. De-barking and chipping machinery is of Swedish manufacture.

Inspected and approved chips are then taken by a 280 ft inclined conveyor to a chip storage silo. From the silo, chips are metered into a steam vessel, steamed, mixed with hot liquors, and then pumped at high pressure to the top of a digester tower. Compressed air is used for many purposes in the actual chemical processing and is provided by four Broom & Wade compressors.

MATERIAL HANDLING.—Chutes for material handling installations are now being made from Fortiflex, Dunlop's rubber resin compound made by the Dunlop General Rubber Goods Division, Cambridge Street, Manchester. Easily cleared on account of their flexibility if blockages occur, they have a substantially longer life than chutes of conventional mild steel and are proof against cracking, splintering and corrosion, besides having high resistance to abrasion. They are also comparatively light in weight and, therefore, easy to erect

The action of chemicals and heat (350° F.) in the digester removes the lignin from the wood and the digested material is then pumped through a blow tank to the refiners. Here, the wood fibres are mechanically separated in the presence of liquor and form a brown, pulp. The pulp is washed, cleaned, bleached in three stages and then formed into an endless web which is slit lengthwise and across. Finally, the web is pressed into a bale weighing 450 lb and transported by Stacatruc to a storage area before being despatched to the papermakers.

Consulting engineers for Sudbrook Mill were W. S. Atkins & Partners; main electrical contractors were George E. Taylor (London) Limited, and the bulk of conveyors for wood and chip handling were designed and built by James Hodgkinson (Salford) Limited and George Robson & Company (Conveyors) Limited, Sheffield, in conjunction with the consulting engineers, to the specifications compiled by Sudbrook Mill engineers.

First A.C. Traction on British Railways

Work on the Manchester–Crewe section of the British Railways electrification plan for the London–Manchester–Liverpool main lines by a 25 kV a.c. single-phase overhead system reached a commendable stage when a nine and a half mile section between Wilmslow and Mauldeth Road, Levenshulme, was demonstrated last November under tractive conditions. The occasion is particularly noteworthy as it is the first time that a passenger train in this country has been hauled by a.c. electric traction.

For the purpose of testing equipment, training crews and for this trial run, the locomotive was No. E 1000, originally a gas turbine which has been rebuilt and equipped by Metropolitan-Vickers Company Limited with cabs to conform as nearly as possible to the design of the new a.c. locomotives.

Ultimately the Crewe–Manchester service which is scheduled to be completed by September, 1960, will have 42 Type A locomotives and 15 multiple unit trains will be provided. The 3300 hp locomotives are of the Bo-Bo type weighing 80 ton, and capable of a maximum speed of 100 mph. The multiple unit sets consist of four cars, one of which is a motor car. There is a driving cab at either end of each set, and two or more sets can be coupled together. The maximum speed of a multiple unit train is 75 mph.

The use of the 25 kV a.c. single-phase system makes it possible to use lighter overhead equipment and supporting structures than has been possible in d.c. overhead equipment electrification schemes. This is especially noticeable on open stretches of track where simple single track cantilevers are employed.

Electricity at 25 kV single-phase a.c. is supplied to the overhead equipment from the Central Electricity Generating board substation via railway owned cables and feeder stations. Sectioning of the overhead equipment is made possible by track sectioning cabins at suitable locations and all circuit breakers and the majority of switches associated with power supply will be remotely controlled from an electric control room which is to be built at Crewe. There are two feeder stations for the Crewe to Manchester stage, one at Heaton Norris and one at Crewe.

In the event of a failure in the supply from one feeder station, it is possible to extend the feeding limits of the other feeder station by suitable switching operations.

One of the major tasks involved is the provision of additional "headroom" for the overhead type electric traction. Alterations are required at 82 over-bridges out of a total of 92 on the section of line concerned. Where possible, a bridge may be raised or reconstructed but where neither is possible the railway track has to be lowered, though this generally is more costly.

Where the existing overhead clearance in tunnels is not sufficient, for example, at Crewe, the goods lines pass beneath Crewe North Junction's complicated track layout, and a major track-lowering scheme has been embarked upon to give additional headroom.

At Edgeley tunnels Stockport, it was decided to remove the top of the tunnels altogether, thus creating a railway cutting across which two road-bridges (one 170 ft wide carrying a roundabout) and one footbridge will have to be constructed.

Resistance Casting

A discovery in resistance welding is now being developed by the British Welding Research Association, Abington, near Cambridge. The discovery provisionally patented, evolved directly from work done at Abington for the United Kingdom Atomic Energy Authority. In spot welding, molten metal is expelled if the welding current is too high or if the electrode force is too low. This molten metal can be directed into a cavity in the welding face of an otherwise normal spot welding electrode. Since it freezes there to form a stud, strongly welded to the parent sheet, the technique is known as resistance casting, or sometimes as stud raising, or pimple welding.

Studs of highly varied shapes and sizes have been formed by this process in a wide range of metals, including steel, stainless steel, light alloys, titanium, and nickel alloys. A peg of similar or different material, inserted in the electrode cavity, can be cast into the stud; strong metallic bonding between the peg and stud can occur with compatible metals, though the purely mechanical joint formed with non-metallic pegs may also be strong. If both electrodes are provided with a cavity, projections will be formed on both sides of the article. Since the metal for the stud is drawn from the molten spot weld nugget it is generally necessary to have at least two sheets of metal between the spot welding electrodes in order to raise a stud.

It is proposed to undertake a survey of possible industrial applications for the new process, but some are already obvious. Amongst the less obvious ones are the raising of projections on tubes or flat surfaces to form heat exchangers. Projections suitable for projection welding can be made by resistance casting on metal too thick to be raised by pressing.

Oil Research

The new Esso Research Laboratories near Abingdon, Berks., built and equipped at a cost of approximately £1M employ over 300 technologists engaged on research into the quality of petroleum products, and research aimed at discovering new products and new methods of manufacture. This is the largest Esso Research Centre in the Eastern Hemisphere and is designed to serve the interests not only of Esso Petroleum Company in the U.K. but also of all other Esso companies operating in Europe and North Africa. It is one of a chain of world-wide Esso research installations which together spent over £20 million last year on research.

It was here, in one of the original prefabricated buildings which the new laboratories now replace, that Esso scientists discovered the formula for oil capable of lubricating such aircraft as the Comet and the Viscount and all high-performance military jet aircraft.

The laboratories are ahead in their use of radioactive engine components as large as cylinder liners for studying the effect of lubricant quality on engine wear. Their equipment also includes apparatus for determining sulphur content by radioactivity using tritium as the source of gamma rays.

Maintenance Workshop

The new road motor maintenance depot for the Scottish Region of British Railways in Glasgow deals with the heavy maintenance of the whole Scottish fleet of some 1600 road motors and 3200 trailers; as well as with the running maintenance of 800 road vehicles and 1500 trailers operating in the Glasgow area. The workshop area is of steel construction with colour glazed insulated asbestos cement roofing and areas of patent glazing on equal pitch trusses. All doorways are fitted with roller shutters, the principal ones being electrically operated. In the paint shop, which is enclosed by an asbestos curtain, provision has been made for spray painting ten vehicles simultaneously. Mechanical extraction ventilation is through ducts in the floor, while filtered and heated air is provided through inlets suspended from the roof. The remainder of the depot is sub-divided by metal wire mesh partitions. Grillage floors have been provided for the wash beds and degreasing bay. A distinctive feature is the use of panel floor heating throughout the general workshop area, by hot water circulating pipes with asbestos cement sleeves embedded within the concrete floor slab.

Central heating and hot water are provided by three solid fuel boilers with bunker fed mechanical stokers thermostatically controlled. Coal delivery is by tipping through hatches in the roof of the fuel store.

Standard Wire and Sheet Gauges

Steps have recently been taken by a representative Committee of the British Standards Institution to obtain the views of industry on proposals to revise the present standard on wire and sheet gauges.

There is a general feeling that the present situation is unsatisfactory, and there is much support for some degree of international standardization. There are strong protests at the number of series at present in use. As many as eight are quoted as in current demand, apart from non-standard sizes. This makes the supply of material, particularly in small quantities, subject to much delay and expense.

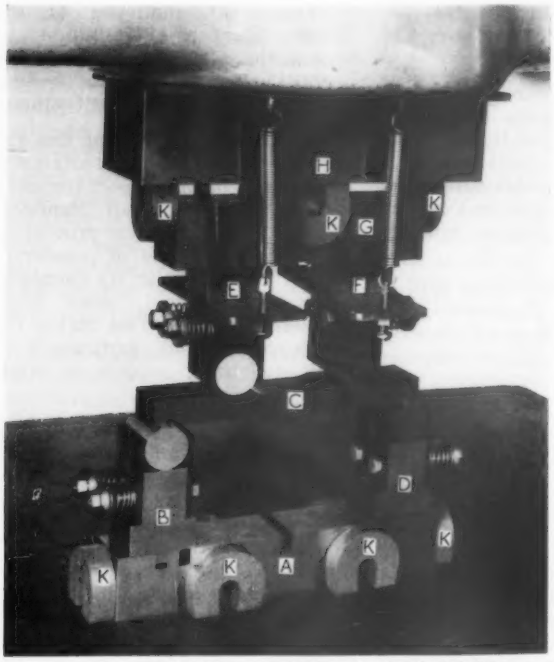
Uniformity and simplicity are obvious attributes to be desired in any system of gauges, and preferably a system of numbers which has some obvious relationship to actual dimensions. The B.S.I. have collected a number of opinions but they want more, and the people who can help are those with practical experience of the use of the various systems. Comments should be sent to the British Standards Institution, 2 Park Street, London, W1.

Mechanical Properties of Ceramics

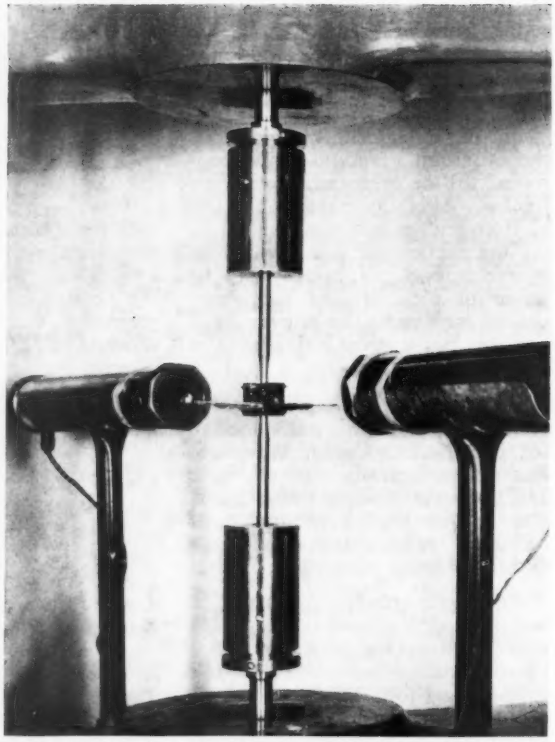
Basic investigations into methods of evaluation

THE U.S. National Bureau of Standards at the request of the U.S. Army's Watertown Arsenal, has recently evaluated the methods generally used to determine the mechanical properties of ceramics. The evaluation was needed because present uncertainty in such data is preventing the successful application of cermets in rockets and missiles.

As the temperature of rocket parts reach higher extremes, the search for materials that resist chemical erosion and maintain their mechanical properties at these temperatures has been intensified. Refractory brittle materials, such as cermets, appear to meet this need, but the lack of reproducible data on their mechanical properties introduces uncertainty in the design and processing of parts. Consequently, failures in performance are more apt to occur, making the missile unsafe or ineffective.



Loading apparatus used in the transverse testing of enlarged-end brittle cermet specimens. Block A spaces supports B and D for specimen C. Load, applied by the crosshead H, is transmitted to beam G and then to the specimen. D, E and F have rocker bases to eliminate extraneous stresses in C. The magnets K position parts



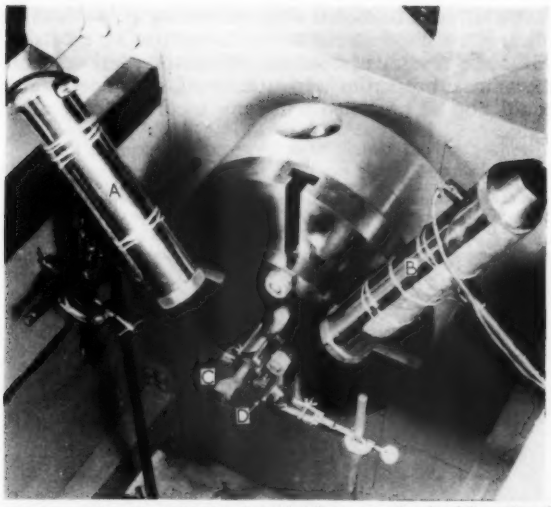
Tensile testing of a gripped-end specimen cermet. Strain is measured by the optical gauge, mounted on the reduced portion of the specimen, and read through collimators at right and left

Obviously, all the properties of a given specimen, if properly determined, should be compatible. For example, Young's modulus of elasticity should be the same and should stand in the established relation to other elastic properties whether it is obtained from tensile, compressive, or transverse tests. To make possible such agreement, the present work was undertaken by M. J. Kerper, L. E. Mong, M. B. Stiefel and S. F. Holley of the Bureau's refractories laboratory.

The disagreement among experimental results for ceramics is attributed to many causes. Extremely important is the brittleness of cermets, which makes it necessary to refine the procedures and improve the apparatus used to study ordinary ductile materials. Also, in ceramic materials, correct distribution of stress is sometimes difficult to obtain and extraneous stresses are easily introduced.

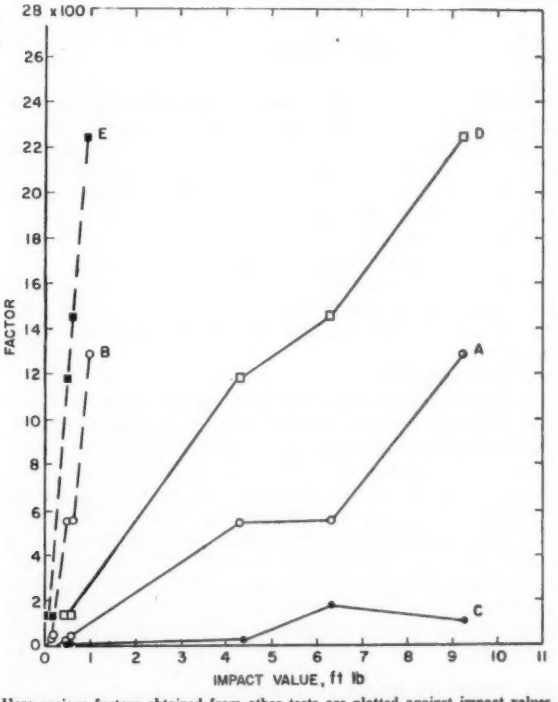
These factors, which limit accuracy, were given special consideration so that errors will not appear in the final strain-gauge determinations. For example, in the tensile tests, several specimen designs, differing mainly in the provision made for applying load, were compared. One of these, the pin-end design (with a hole at each end to allow mounting)—previously considered adequate for tensile tests—was found unsatisfactory because of excessive stress concentrations. Although other designs were suitable, the final correlation of the results from all types of tests shows that best results are obtained with specimens grooved at the ends, the gripped-end design.

A particular type of mounting arrangement was adopted for compressive tests because of the difficulty in securing satisfactory alignment. The usual ways employed to secure alignment of the specimen—spherical bearings



Apparatus employed in torsional testing of brittle cermets. Angular deformation of the specimen C is measured by optical twist gauges with the aid of autocollimators A and B and a right-angle prism D.

or a cast-in-place layer of plaster of paris—gave a non-uniform distribution of stress; in some cases one side of the specimen was actually in tension. Successful alignment was secured with specimens having parallel ends set between flat-bearing blocks on anvils to which the load is applied. To eliminate another source of error, very hard bearings were used, preventing specimen penetration. These were reground after each test to remove roughness.



Here various factors obtained from other tests are plotted against impact values. Energy values are plotted against impact values for unnotched specimens A and notched specimens B; moduli of resiliency against impact values C; and the product of compressive strength and tensile extensibility against impact values for unnotched specimens D and notched specimens E

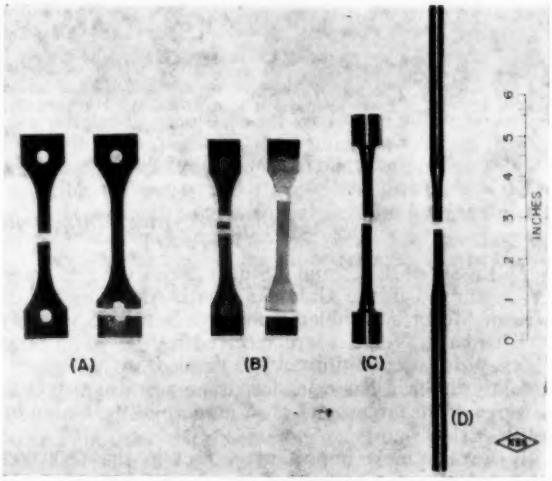
To assure that the stresses being measured in torsional tests are due to twisting only, a special machine is employed. In other tests of this type, bending of the specimen is often present to some degree, making results inaccurate. Such extraneous causes of stress are eliminated by a frame that is symmetrical about the specimen axis.

An apparatus to prevent undesirable stresses was designed for the transverse test also. Here rocker bases eliminate stresses due to causes other than simple bending.

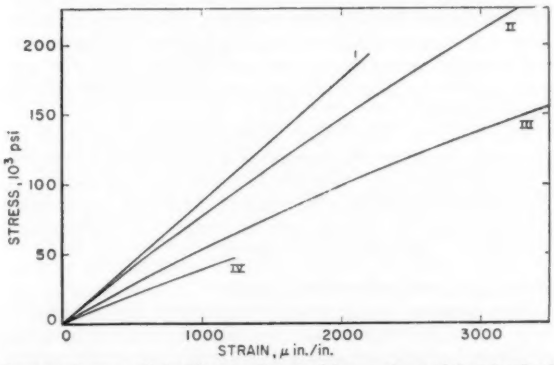
The correlation of results from the modified tensile, compressive, torsional and transverse tests indicate that elastic properties can be obtained satisfactorily from each. Poisson's ratio is the exception, being too low for stubby transverse specimens.

A comparison of the four tests shows that all are approximately equal in complexity and cost. The tensile test has the advantage of yielding tensile strength directly without corrections for plasticity or creep. The compressive test has the same advantage in shear strength determinations. Thus, these two tests are preferable for the determination of significant mechanical properties.

On the other hand, the transverse and torsional tests give the transverse and torsional strengths, and are most



Specimen types used in tensile testing of brittle cermets. The typical fractures are of pin-end A, T-end B, shouldered-end C ,and gripped-end D under tensile load



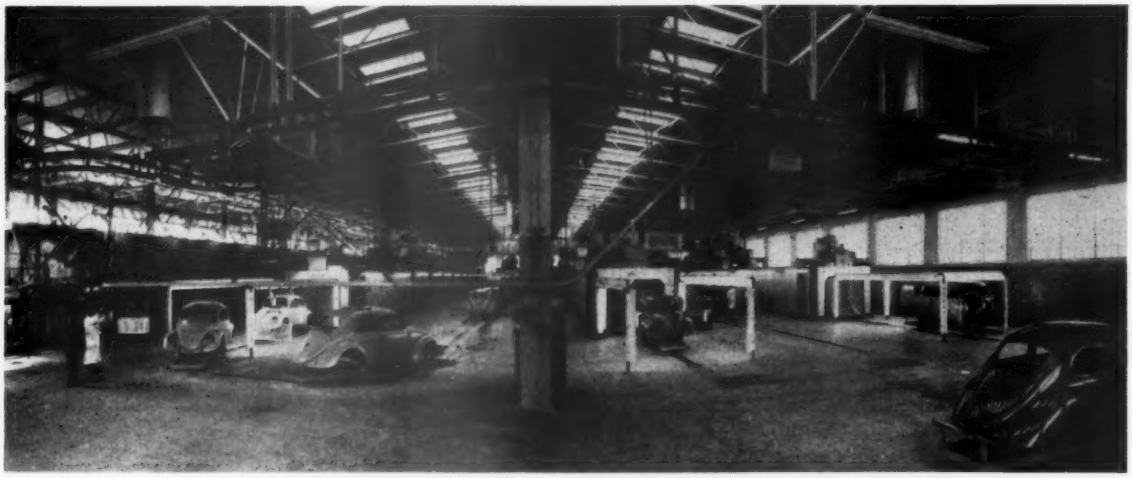
Stress-strain curves obtained from tensile tests of four specimens of the gripped-end design. Stress-strain curves for transverse, compressive and torsion tests are similar to those for tensile tests

useful in design problems which include bending and twisting application. The tensile strength may also be calculated from the transverse and torsional strengths by making corrections based on surface strain measurements.

In addition to the tests mentioned, impact tests were conducted and were found to give some indication of the performance of materials subjected to sudden loading. As the energy causing fracture is only a small fraction of that which can be stored without fracture at low loading rates, stress concentrations are thought to be excessive. Although several correlations of factors derived from mechanical properties were attempted, the impact value could not be predicted with any accuracy from other tests.

Reference

"Evaluation of tensile, compressive, torsional, transverse and impact tests and correlation of results for brittle cermets", by M. J. Kerper, L. E. Mong, M. B. Stiefel, and S. F. Holley, *J. Research NBS* (in press).



New paint shop at South African Motor Assemblers & Distributors Limited, (SAMAD), Uitenhage, South Africa

Vehicle Painting Plant

Complete mechanized installation in South Africa

VOLKSWAGEN and Studebaker vehicles are assembled in the Union of South Africa by South African Motor Assemblers and Distributors (SAMAD) at Uitenhage. Vehicles are received in the completely knocked down condition and assembled at the factory. Recently the firm has extended its premises so that it is now one of the largest and most modern in the Union of South Africa.

By far the most important project in the £500,000 extension plan just completed was the building of a new paint shop which sets a new standard in body finishing practice, and which incidentally contains the largest paint dip tank in the Southern hemisphere. The complete paint shop was designed and manufactured by The Incandescent Group, manufacture and installation being the sole responsibility of the Incandescent Group (South Africa) (Pty.) Limited.

The body is transferred from the body shop in an adjoining building by means of an overhead conveyor. It is transferred to a twin chain flight bar conveyor with intermittent operation, the progress of which is regulated automatically at 4·8 minute intervals. The subsequent progress of the body is as follows:

Phosphating and prime coat section

This section which is approximately 370 ft long, is fully automatic except for the dipping operation when the body is fully immersed in the paint tank. This complete line is served by two intermittent flight bar conveyors, both of which are synchronized to work in conjunction with the doors and pumps of the phosphating plant, and the doors on the two ovens.

Each section in this line is divided into 20 ft stations and bodies remain in each station for a period of 4·8 min before moving to the next station. The various compartments in this section are:

(1) Loading deck
(2) Alkali degrease (spray) at 160°F
(3) Cold rinse (spray)
(4) Spray phosphate at 140°F
(5) Hot rinse with 1/20th % chromic acid at 130° F (spray)
(6) Blow-off station
(7) Three stage indirect oil fired dry-off oven
(8) Transfer station, where the body is lifted from the slat conveyor by means of an overhead air operated hoist, ready for dropping into the prime paint dipping plant. In each section of the pretreatment unit, between the opening and closing of the doors, the pumps are in action for approximately 2½ min, and then stop, draining taking place until the doors open. The dry-off oven, approximately 60 ft long, is a three stage unit, and is heated by air circulation, the heating medium being indirect oil fired heaters burning light diesel oil; oven temperature up to 400°F.

(9) Prime dip tank

This is the only dip tank in South Africa exclusively used for the complete dipping of the car body shell. The tank is approximately 22 ft long by 9 ft deep by 8 ft wide.

In normal operation the tank is filled with 9000 gal of paint. To make certain that there is no resettlement of the paint two recirculating pumps have been installed, one to stand by should the other one fail.

(10) Three stage draining section

When completely covered with paint the body shell is lifted from the tank and placed on the second slat conveyor, and surplus paint runs off into the drain trays. This section, together with the dip tank area, is completely enclosed by means of a canopy constructed of steel sections, steel sheeting, and reinforced glazing to obtain as much natural light as possible. The object of this canopy is to confine the volatiles within this area. Filtered fresh air is supplied by an input fan, blanketing down air over the dip and drain section, and the heavy fumes are extracted by an exhaust fan connected to ducting running underneath the steel grid walkways on either side of the dip and drain section.

As the above section represents a major fire hazard, the following safety precautions have been taken.

(a) A carbon dioxide distribution station over the whole dip and drain section has been installed.

(b) A paint dump tank, beneath the ground outside the paint shop, but adjacent to the dip tank has been installed.

In the event of fire, the carbon dioxide is brought into commission, either manually or automatically, blanketing the dip tank and drain section with carbon dioxide gas. At the same time as the gas is released, two large valves are automatically opened in the bottom of the dip tank, draining the paint into the dump tank, thus preventing a serious fire, and also saving the paint from excessive damage.

(11) Prime bake oven

This is a three stage oven 60.ft long, heated by air circulation, the heating medium being an indirect oil fired heater designed to burn light diesel oil. Vertical sliding doors, automatically operated, are fitted to this oven, as on the phosphate and water dry-off ovens previously described.

(12) High level conveyor

When the body is delivered from the prime bake oven, it is lifted by an air operated hoist on to a high level conveyor, which is approximately 70 ft long and 7 ft high. The construction of this conveyor is similar to the slat conveyor running through the phosphating section, but in this instance is running continually at a speed of 5 ft per min.

From the high level conveyor, the body is lifted by an air operated hoist and placed on the floor conveyor which conveys the body through all subsequent operations, i.e., spray booths, baking ovens, flatting decks and inspection points.

(13) Spray booths

There are three spray booths, constructed in identically the same manner. Each booth is served by a 20 ft tack-off section, and approximately 30 ft flash-off sections. Each booth has four extraction fans, capable of exhausting a total of 72,000 cfm. This exhaust air is scrubbed by means of water sprays in baffled ducting, before being passed to atmosphere, thus ensuring that no paint fumes or overspray are thrown outside. Each spray booth has its own water pump, driven by a 75 hp motor, and capable of delivering 2000 gal of water per min. All three pumps are situated outside the paint shop.

(14) Reinforced concrete tank

A reinforced concrete tank 50 ft by 40 ft, with a capacity of 60,000 gal of water, has been constructed outside the paint shop. Adjoining this tank, three pumps pump the water through 12 in. pipelines to the spray booths, and the water then gravitates back to the tank through a common large diameter pipe. Overspray carried through the spray booth back to the recirculating tank is removed from the water by two banks of coke filters before the water is pumped back for further use.

To replace all the air exhausted from these three booths, the following equipment has been installed in a separate filtration building.

(a) Three input fans driven by 45 hp motors, each capable of delivering 80,000 cfm.

(b) Three banks of electrostatic filters working at 20,000 V which remove all the dust particles from the air before it is delivered to the spray booths by means of large overhead ducts. These ducts are approximately 30 ft square in cross-section and have been fabricated from the light galvanized sheet metal. A downward air flow is maintained over the car body being painted. The air passes through a grill, and across the water surface to the baffle plates in the towers, where a water spray thoroughly cleans it.

The air speed in the booth is approximately 120 ft per min, and to maintain a state of plenum in the booth, the inlet of conditioned air is about 10% greater than the booth extraction.

(15) Baking ovens

Three paint baking ovens have been installed immediately following the flash-off sections. Each oven is over 100 ft long, and each has two zones for heating, through which air is recirculated round heat exchangers before entering the ovens. All three ovens are fitted with air seals at each end to prevent hot air from leaving the oven area, and keeping cold air out.

The three ovens, as mentioned above, are heated by air circulation from heat exchangers, the fuel being light diesel oil.

(16) Flatting decks

On the flatting decks two 40 ft long ovens have been installed for drying off any moisture that might be left on the body after the wet sanding operation. Both ovens are direct oil fired. No heat exchangers and air seals have been fitted, as the ovens are only drying off water.

(17) Inspection points

At inspection points the body is examined very carefully for blemishes; bodies that do not pass inspection are returned to the appropriate section.

General layout

The main building of the new paint shop covers an area of approximately 60,000 sq ft, and is separate from the main assembly buildings.

Working in conjunction with this job are a paint mix building, 1600 sq ft in area, and a paint store also 1600 sq ft, which, due to the highly volatile liquid stored in it, is approximately 300 ft away from the main building.

The air filtration building adjoins the paint shop, and is approximately 1500 sq ft in area. This building is used solely for the housing of the equipment supplying clean filtered air to the three body spraying booths.

Between the filtration building and the paint mix building, is the large open top concrete water tank described above.

Details of the main building

This building is constructed of reinforced concrete columns, with brick and reinforced glazing between the columns. All the windows are non-opening, and the roof is completely sealed to ensure that no dust can enter. Ventilation is by means of ten input fans, complete with filter box situated in the roof over main working areas, and ducted down to approximately 16 ft from the floor. The hot foul air rises to the roof and escapes through an adjustable ridge ventilator which is 380 ft long.

To prevent dust from rising from the floor, due to trolleys passing around the conveyor track, a special ferrous salt was added to the top dressing of the concrete, and not only does this prevent dust, but it also obviates having to sink special guide tracks into the floor on which the body trolleys normally run, as this surface is extremely hard.

Conveyor system

The paint shop is served by a system of conveyors which carry the body shell during the entire painting system. An overhead conveyor brings the body in from the body shop, and returns carrying the finished painted body back to the trim line.

Overhead tunnels were constructed between the main assembly building and the paint shop, to carry the body conveyor. There is also a light duty conveyor to handle the small parts requiring painting. This small parts conveyor winds right through the main plant, commencing at the unboxing area adjoining the railway siding. Unpainted parts are loaded on to the conveyor, and are carried overhead to the paint shop, where they are painted, and loaded back on to the conveyor for distribution to the assembly lines. This conveyor is approximately 1800 ft long, and can be adjusted to run at speeds between 2 and 6 ft per min by means of an electronic control panel situated within the paint shop.

As mentioned above, through the Bonderizing plant and the paint drain and bake sections the bodies are conveyed by means of two intermittent flight bar conveyors. The first conveyor operates between the loading platform and the platform next to the paint dip tank. The second conveyor starts at the rear end of the paint dip tank, and runs to the transfer deck at the end of the prime bake oven.

For convenience and ease of operation, there is a short overhead flight bar conveyor, carrying the car bodies through the section where the sound deadener and underbody sealers are applied.

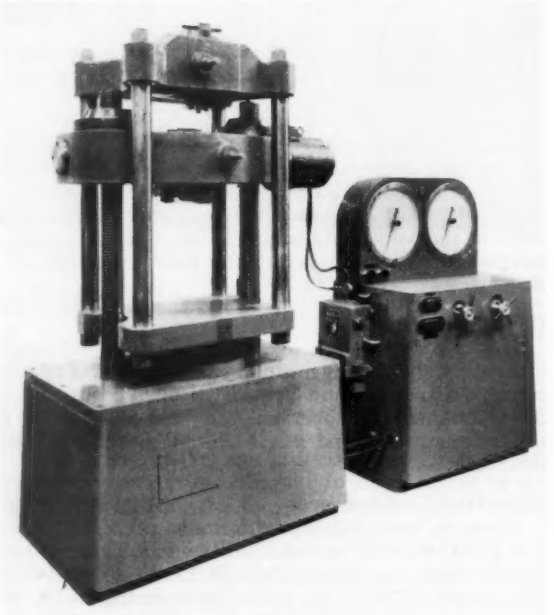
To carry the body shells from the various spray booths, ovens, flashing decks, etc., there has been installed a single strand conveyor with an approximate overall length of 2050 ft, and which is variable in speed from 1 ft 6 in. to 5 ft per min, according to the rate of production flow required. All the conveyors were manufactured by George King Limited.

Hydraulic Testing Machines of Increased Capacity

The success of the small capacity Olsen L type universal hydraulic testing machine in recent years has merited a considerable extension to the capacity range. These machines are ideal for the rapid testing of standard specimens and Edward G. Herbert Limited of Atlas Works, Chapel Street, Levenshulme, Manchester 19, who manufacture Tinius Olsen testing machines under licence in this country are now building them in five capacities; 60,000, 120,000, 200,000, 300,000 and 400,000 lb. Each machine has an additional capacity range of $\frac{1}{5}$ or $\frac{1}{6}$ of its full capacity.

The first 400,000 lb capacity machine illustrated here is designed so that the complete hydraulic and mechanical systems are enclosed in a low weight welded frame which forms a compact unit. Tensile and compression tests are covered by the standard equipment of flat grips V-grips and a compression plate and a complete range, of accessory testing tools are manufactured to cover, transverse, shear and bending tests.

The loads are indicated on two 16 in. dia precision hydraulic gauges which are mounted on the instrument panel above the hydraulic and electrical controls. These gauges are provided with maximum pointers. Hydraulic pressure is developed in a ground and lapped piston and cylinder which are designed to operate without packings of any kind, a slight film of oil providing a seal at all times. With this design, friction is held to an absolute minimum and the load is weighed within close limits, and the machine is built to Grade "A" accuracy.



The 400,000 lb capacity Olsen hydraulic testing machine

The load is applied to the specimen by a hydraulic piston and cylinder which are located in the base of the machine to keep centre of gravity extremely low. This feature eliminates the necessity for any rollers or guides and reduces the shock of breaking specimens. The hydraulic pressure is developed from a direct-connected motor driven gear pump which coupled with the Olsen automatic valve, provides uniform rate of load application. A safety valve and electric limit switches protect the gauges from overload. Normally a range of testing speeds from 0 to 2 in. per min is obtainable in stepless intervals and the control is by two pilot hand wheels.

On the 60,000 lb machine the middle crosshead is conveniently adjusted by means of a hand crank which is within easy reach of the operator, but on all other machines the crosshead is adjusted by an electric motor. The entire loading unit is rigidly constructed and braced by tie bars linking the top crosshead and table units.

Embrittlement of Alloy Steels

One of the most frequent and perplexing phenomena in steels of alloy type is the occurrence, under widely differing conditions, of embrittlement. In the following notes the subject is discussed from both its microstructural and practical aspects

EMBRITTLEMENT is a structural instability in a material produced by various causes. Among these may be mentioned steady, high stresses in the presence of a strong alkaline solution; the inter-molecular penetration of the steel by nascent hydrogen; shock or stress without appreciable deformation. Brittleness itself may be defined as: (a) the want of ductility or malleability; (b) a tendency to fracture without appreciable deformation; or (c) the tendency to fracture without appreciable deformation and under low stress.

The potential strength level range is in excess of 156 tons/in.^{2}. Today, however, the practical serviceable range is at least 45 tons/in.^{2} below that level. This is because when hardened steel is tempered within the range 260–310° C, ductility appears to undergo a decline.

Brittleness is indicated in the tensile test by a low ultimate tensile stress and extremely low elongation percentage and reduction of area percentage. The notched bar impact test may, however, show brittleness in metals that give a high ultimate stress. In most instances the test conditions must be more severe than the standard tensile test if precise indications of embrittlement are to be revealed. This tendency of steel to embrittle when hardened and then tempered within the range 230° to 310° C has long been known. It was believed, as a result of extensive research, that the cause was a precipitation and agglomeration of carbides, which developed a boundary network of ferritic grains. Such a frail network was proved, it was said, to cause embrittlement.

Further investigations into this subject revealed that tempering and the conditions under which it was carried out also affected the embrittlement of the steels. For example, at a specific tempering temperature, there was a tendency to brittleness unless the tempering period was increased. At low tempering temperatures, embrittlement would only occur if a hardened structure was present after cooling from the austenitizing temperature. At a comparatively high tempering temperature, embrittlement declined if short tempering periods were employed.

The type of brittleness found in alloy steels at 260° C is apparently affected by the type of alloying elements included in the composition of the steels. For example, chromium and manganese both develop embrittlement, either singly or together, whereas molybdenum, tungsten and vanadium have little influence on this property at the temperature stated. Steels with more than 5% nickel also undergo little embrittlement. Even small aluminium contents reduce brittleness. Thus, 0·04% reduces it, and 0·1% eliminates it entirely. Such additions must be deliberately made, however, as they are greater than is required for grain refinement. The explanation offered is that chromium and manganese form embrittling nitrides, whereas aluminium forms aluminium nitride, insoluble in solid solutions and therefore incapable of precipitation in tempering.

A theory recently put forward is that there is some connexion between the brittleness experienced when steels of alloy type are tempered within the range 260° to 370° C and the formation of carbide when martensite is tempered. Consequently, it is suggested, a steel in which the microstructure is not preponderantly martensitic will retain its toughness. In fact, plain carbon steels which have been subjected to an austempering heat treatment have been found to give better resistance to both tensile stresses and impact when treated to the higher strength levels. For the majority of alloy steels, however, the range of temperature within which austempering will produce the required structure is extremely restricted, but it so happens that a low temperature acicular bainite formed by the isothermal transformation of austenite in the lower temperature range is able to produce high strength, and at the same time to reduce embrittlement. It must be borne in mind, nevertheless, that we are still in a state of patient experiment, and the issue is not fully decided.

The latest researches appear to establish that embrittlement when quenched steels are tempered to give high levels of strength is the result of precipitation or ageing, and is therefore responsive to composition, tempering time and temperature. Obviously, therefore, the tempering properties of the material greatly affect embrittlement. Steels which rapidly soften show different time-temperature combination for embrittlement from those less readily softening, but all are capable of a degree of embrittlement.

A fully bainitic structure gives superior resistance to embrittlement as compared to a microstructure in which bainite is only part of the whole, and this frequently explains why some steels embrittle at the 260° C temperature whereas others do not, since some steels cannot be treated to produce a fully bainitic microstructure within an extremely narrow temperature range.

We now come to consider how far these results of research may help in the reduction or prevention of embrittlement in steels at high strength levels. The first suggestion is that we should endeavour to develop steels having special analyses showing tempering properties such that martensite formation is delayed. In fact, this has been tried and has been found to give promising results. Another suggestion is that we must pay greater attention in slow-tempering steels to the relation of tempering time to tempering temperature. For example, it is known that such steels may show brittleness with one combination of time and temperature and absence of brittleness at a less advanced stage of tempering.

A further possibility of some importance is the production of steels that are faster martensite-tempering, so that over-ageing takes place and therefore embrittlement is completely prevented at normal tempering times. Such a beneficial result will be facilitated if, in addition, the steel is cold-worked, as this abbreviates the over-ageing period. On the other hand, this method falls short of giving the desired high levels of strength.

Then there is the production of steels which are capable of responding to treatments designed to develop a fully bainitic microstructure. Such steels usually call for an increase in the carbon content, but this does not necessarily involve a greater susceptibility to embrittlement, as the bainite microstructure is made stronger by the additional carbon, and the attainment of 100% bainite is facilitated. Of the various suggestions, this appears to hold out the greatest promise, particularly at high levels of strength demanding carbon steels which, if of martensitic microstructure after being tempered, would be extremely brittle.

It is only fair to state that not all metallurgists agree with the relative importance of these proposals as outlined here. Some, for example, are of the opinion that delayed martensite formation in a tempered steel is more important than the fully bainitic structure, and that the best properties in steel are achieved by keeping the carbon content to the minimum essential for the required level of strength, and tempering to a temperature below the point at which iron carbide (Fe_3C) begins to precipitate.

An alternative suggestion is that a reduction of the tempering temperature to approximately 200° C would give greater hardness combined with adequate freedom from embrittlement.

It will thus be appreciated that the subject is not yet exhausted and that there is not complete agreement on either the cause or the cure of the form of embrittlement described.

Another form of brittleness well-known to engineers is temper brittleness, which has been the subject of experiment and research during the last fifty years or more. It presents a fascinating problem, because there is still not enough known about its causes and mechanism. It seems to be an intercrystalline embrittlement occurring more quickly upon ageing at a temperature of approximately 480° C, or when a steel is slowly cooled through this temperature region. It is regarded as a reduction of the cohesive strength of the undeformed metal, and is revealed by a reduction in the resistance of the steel to brittle fracture. A coarse-grained steel is more liable to temper brittleness than a fine-grained steel. Liability to temper brittleness seems to be virtually a sole function of the alloy content of the steel, or, to put it more exactly, of the alloying elements in solution in the ferrite matrix. The elements having the greatest effect in producing temper brittleness in a steel are phosphorus, manganese, chromium and, to a smaller degree, nickel. Molybdenum and tungsten largely reduce the liability to this form of brittleness. On the other hand, it is not certain that these two elements preserve this inhibiting effect in amounts above 0·75%. A specific research into this matter appears not to have been instituted until 1956, when it was established as a result of a series of careful experiments that both molybdenum and tungsten have an intricate influence on the temper brittleness of a steel containing 1% chromium and 1% manganese.

It appears that as soon as the molybdenum or tungsten content increases above 1% for molybdenum and 2% for tungsten, the liablility of the steel to temper-brittleness is equal to that of the steel in its normal chromium-manganese basis composition. In other words, the inhibiting effect of tungsten and molybdenum disappears.

It was also found in the course of these experiments that at temperatures in the region of 540° C, the equilibrium degree of embrittlement was increased by all molybdenum and tungsten contents up to 2%. If, however, low ageing temperatures of 430° C and below were adopted, the rate of embrittlement was reduced whatever the content of tungsten or molybdenum up to 2%. In every instance the effect of tungsten resembles that of molybdenum for equal atomic contents and is equally influential in eliminating temper brittleness. To give the minimum temper brittleness during slow cooling, at least 0·5% molybdenum or 1% tungsten is required. Slow cooling from the tempering temperature for two weeks will embrittle the steel just as much as if it had been isothermally aged for six weeks at the best embrittling temperature.

It has been known for a long period that certain alloy steels are subject to creep embrittlement. Among these steels are those of chromium-molybdenum-vanadium and chromium-nickel-copper type. One of the most recent researches has been into the effect of normalizing and tempering methods on this form of embrittlement. As a result, certain conclusions have been put forward, which are interesting, though they are not yet to be regarded as final. It is believed that variation in heat-treatment has a considerable influence on the creep embrittlement of these steels, and that the tendency to embrittle is strengthened by normalizing at temperatures in excess of 940° C, or lessened by normalizing at lower temperatures. Should high temperature normalizing develop creep embrittlement, renormalizing at a lower temperature is a remedial treatment that may be adopted without adverse effects.

Creep embrittlement of steels of the type described when these are normalized at high temperatures is said to be mainly connected with the carbide structure. Carbide precipitation from ferrite may take place either during tempering or during testing for creep. It (the precipitate) will have a greater embrittling effect if it occurs during creep testing than if it occurs during tempering.

What this amounts to is that superior mechanical properties as regards creep embrittlement may be secured by correct heat-treatment of the steels concerned. When these properties are obtained, metallurgical changes are effectively reduced and the steel remains stable.

Much work still remains to be done on brittleness, but unquestionably the subject is not being overlooked in the research laboratories of the world.

Spray Dressing moving Belts

First introduced in America two years ago by an associated company of Graton & Knight Limited, a vapourized belt dressing, Sprazon suitable for any kind of V-belt or flat belt whether it be made from leather, rubber or fabric is now available in this country.

Application is extremely simple, a running belt may be completely treated in a few seconds by spraying Sprazon from 12 oz containers with pressure valve. The result is instantaneous, the dry surface of the belt vanishes and the dressing which is non-injurious to belts or fabric is claimed to prolong belt life and restore the frictional driving surface. Sprazon is marketed in this country by Graton Knight Limited, Warwick Road, Boreham Wood, Herts.

A Comparison of the Principal Design Data on Nuclear Power Stations in Great Britain

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BRITISH engineers are today in an admirable position to be specially proud of their imposing record of notable achievements in the field of civil, mechanical, electrical, nuclear and chemical engineering and metallurgy, for their ingenuity, researches and skill are so effectively demonstrated by a series of nuclear power stations in operation and under construction.

From the point of view of supplying large quantities of cooling water for the generation and the distribution of electric power, such stations are located wisely at various points of the coast line of England and Scotland and on the shore of a lake in Wales. Thus with the advent of nuclear energy, engineers with a special flair for design and those with unique experience in manufacture, erection and operation of special plants have undoubtedly raised British prestige, and high praise is due to the team of eminent experts—the consultants, technical advisers and highly trained designers, the manufacturers of some of the intricate plants, and finally to the civil engineering contractors. Their valuable collaboration has had the desired result of guaranteeing the success of these major projects.

Although only a very few were privileged to receive official recognition coupled with high honours for these remarkable achievements, one must not forget to pay a well-merited tribute to those who have played an important role and have been primarily concerned with the final essential details of the remarkable pioneering researches and developments which have resulted in a notable advance in power generation on a large scale. Such determined efforts provide an excellent opportunity for the British engineering industry to enlarge further its impressive record in supplying power plant overseas.

From time to time during the past few years a mass of interesting and useful information has been published. The main objects of the present contribution are:

(a) to review briefly the advances in nuclear power stations in this country

(b) to direct special attention to certain aspects of the steam cycle

(c) to consider the characteristic features of the steam turbines and the circulators

(d) to summarize the essential particulars and the details relating to the design of the plant

(e) to correlate and compare the design data of the various sections of the power plant.

For this comparison the nuclear power stations listed in Table I have been selected.

The United Kingdom Atomic Energy Authority has recently received permission to proceed with the design and construction of an advanced gas cooled reactor, to be known as A.G.R. It is an experimental reactor for the study of further developments in the direction of higher operating temperatures and ratings. The essential particulars relating to its design and performance will also receive attention.

1. Approved types of nuclear reactors for large base load power stations

Although a number of experimental nuclear reactors with different moderators and coolants have been designed, constructed and meticulously investigated during the past decade, particularly in Great Britain and the U.S.A. there are three well-established reactors which are admirably suited for large power stations. These approved types of reactors are classified in Table II.

The graphite-moderated gas-cooled reactor has been selected for nuclear power stations in Great Britain and are based on the prototype at Calder Hall, the world's first full scale nuclear power station.

The pressurized and boiling light water-moderated and cooled reactors were originally introduced in America but American engineers have since turned their attention to the graphite-moderated gas-cooled reactor and are proceeding with such projects.

The most significant feature of the graphite-moderated gas-cooled reactor is that it uses natural uranium as fuel containing uranium 235 in proportion 1 in 140, i.e. 0·72%, the remainder being uranium 238 which does not undergo fission. The pressurized and the boiling light water-moderated and cooled reactors require enriched uranium containing generally about 1·6% to 2·5% U235, which is produced at great expense in a gaseous diffusion plant. The generating capacity required to supply the power to such plants is exceptionally large—in November, 1952, the U.S. Atomic Energy Commission decided to spend 3,000 million dollars (£1,100 million) on a remarkably large programme which consists primarily of constructing an entirely new gaseous diffusion plant on a 6,500 acre site in Pike County, Ohio, and extending the existing plants at Oakridge and Paducan (Kentucky).

Table I.—BRITISH POWER STATIONS WITH GAS-COOLED REACTORS

Station	Total Net Electrical Capacity	Owner
1 Calder Hall 'A' and 'B'	70	U.K.A.E.A.
2 Chapel Cross	70	"
3 Berkeley (Gloucester)	275	C.E.G.B.
4 Bradwell (Essex)	300	"
5 Hunterston (Ayrshire)	320	South of Scotland Electricity Board
6 Hinkley Point (Somerset)	561	C.E.G.B.

Table II.—ESTABLISHED TYPES OF REACTOR

Case	Type	Country of origin
1	Graphite-moderated gas-cooled (G.G.C.R.)	Britain
2	Pressurized light water-moderated and cooled (P.W.R.)	U.S.A.
3	Boiling light water-moderated and cooled (B.W.R.)	U.S.A.

The tremendous size of Pike County plant can be judged by essential particulars given in Table III.

Table III.—PIKE COUNTY, U.S.A., GASEOUS DIFFUSION PLANT

1	Estimated cost	$1,200,000,000 (£436,000,000)
2	Power required: initially	400,000 kW
	maximum	1,800,000 kW
3	Capacity of each turbine, M.C.R.	200,000 kW
4	Number of turbines	10
5	Completion period	4 yr
6	Total number employed	4,000

It is obvious that America is in a fortunate position, to be able to accumulate such remarkably large quantities of enriched uranium 235. Consequently the Americans are most anxious to make full use of these enormous supplies in their reactors for nuclear power stations.

An additional advantage of graphite-moderated gas-cooled reactor is that it enables the production of superheated steam up to 700°F with a fuel temperature of 800° F. and a gas outlet temperature at the reactor of 745° F. However, both the boiling light water and the pressurized light water-moderated and cooled reactors generate only saturated steam at a temperature determined by the pressure of the water in the reactor so as to prevent boiling. The pressures normally used in the reactor are 2000 and 1500 psig for the pressurized light water reactor, the corresponding saturation temperatures being 636·9°F and 597·5°F respectively. Such a plant produces saturated steam at about 600 psig and 488·9°F at the turbine stop valve. Pressure of boiling water in the reactor corresponds to that of the saturated steam, which would normally be 600 psig (488·9°F). The great disadvantage of saturated steam at the turbine stop valve is that either one or more water separators must be inserted at intermediate points of the expansion through the turbine to remove the moisture and thus ensure that the wetness at the turbine exhaust is no greater than normal. It is of special interest to point out that superheated steam could be produced by inserting before the turbine a separately fired superheater; either coal or oil might be used.

The first nuclear power station in the U.S.A. was started up in 1957. It is at Shippingport, Pennsylvania, and is owned by the Duquesne Light and Power Company. A pressurized light water-moderated and cooled reactor was selected for this particular plant. The thermal rating of the reactor is 232MW and the single cylinder turbine is designed for a gross capacity of 100MW at 1800 rpm. A net thermal efficiency of 26·6% is expected.

It is of interest to recall that the above type of reactor was installed in the first nuclear powered submarine, the U.S. *Nautilus:*

(a) With the original nuclear fuel she did 62,560 nautical miles of which 36,498 were under water. The first refuelling was in April, 1957

(b) Under-water speeds up to 25 knots were obtained for prolonged periods the average being 15 knots

(c) Operation was successful and free from trouble

(d) Up to August, 1958, she had travelled 129,000 nautical miles on nuclear power and cruised submerged for over 91,000 miles

(e) She was the first submarine to cruise submerged under the North Pole and remained under the ice for 96 hours. She covered 1830 nautical miles at a speed of 20 knots at a depth of 400 ft.

The power plant of the *Nautilus* consists of one pressurized light water reactor, two heat exchangers and two turbines each driving a propeller. The fuel is 40% enriched uranium. It is apparent from the operational experiences the U.S. Navy has achieved success with the pressurized light water reactor.

The United States have in hand an extensive construction programme for nuclear powered vessels, including an aircraft carrier, a guided missile cruiser, more submarines, an icebreaker for the polar regions and two merchant ships.

In Britain, the experimental zero energy reactor "Neptune" has been installed at Harwell for the study of the behaviour of neutrons in water-moderated core design, and the construction undertaken of a land-based prototype for H.M.S. *Dreadnought* at Dounreay. The "Neptune" uses enriched uranium as fuel and ordinary water as the moderator. The reactor is not pressurized since the heat output is small and boiling cannot occur, even at atmospheric pressure, but the water can be heated to about 190°F to study the variations in the neutron behaviour caused by increased moderator and fuel temperatures. The reactor went critical on November 7, 1957.

More recently the Admiralty have placed a contract with the Westinghouse Electric Company of America, for the purchase of a nuclear power unit for H.M.S. *Dreadnought* which is to be in commission in 1961, i.e. six years after the first atomic submarine *Nautilus* went into service.

2. Calder Hall chronology

The progress on the graphite-moderated gas-cooled reactor and other equally essential plant are indicated step by step in the following summary:

1948	Parolle Electrical Plant Company, C. A. Parsons & Company Limited, and Babcock and Wilcox Limited were requested to study in greater detail the steam cycle and the necessary plant.
1950 (Sept.)	Harwell reviewed the possibility of obtaining power from a reactor fuelled with natural uranium.
1951	Design team set up at Harwell to make a special study of the project. A report was presented and a small nuclear plant known as "PIPPA" (pressure pile production power and plutonium) was proposed.
1952 (June)	This small plant "PIPPA" was found to be impracticable, consequently it was decided to direct special attention to a full scale plant of 150,000kW (heat) of the original "PIPPA" design.
1952	Engineers were brought in from industry. C. A. Parsons & Company Limited on the turbines, condensers and gas circulators; Babcock and Wilcox Limited on the heat exchangers and Whessoe Limited on the design of the pressure vessel for the reactor core.
1953 (Feb.)	The Government accepted a recommendation to build a single "PIPPA" type reactor.
1953 (April 7)	The Industrial Group of the U.K.A.E.A., Risley, took over the control of the entire design in collaboration with the firms mentioned

above. It was agreed to build the plant alongside the Windscale plutonium factory on the river Calder. The second reactor was authorized within a few months. "PIPPA" had been conceived primarily for power generation and also to produce plutonium.

1953 (Aug.) Work started on site.

1956 (May) Reactor No. 1 started experimentally.

1956 (Oct. 17) Station opened officially by the Queen.

1957 (April) No. 2 reactor in operation. No. 1 reactor discharged to bring the temperatures in line with design. It was refuelled and restarted.

1958 (March 12) No. 1 reactor of Calder Hall–B was started up.

1958 (June 28) Explosion in the 23MW turbine, No. 2 set, at Calder Hall–B.

3. Essential particulars and performance data of British nuclear power stations

An appreciation of the advances in nuclear power plant is best gained by presenting a detailed comparison of the essential particulars and the performance data of nuclear power stations in operation and under construction in Great Britain, as indicated in Table V for Calder Hall–A and –B, Berkeley (Gloucestershire), Bradwell (Essex), Hunterston (Ayrshire), and Hinkley Point (Somerset). As Chapel Cross near Annan (Dumfriesshire) is a duplicate of Calder Hall it has not been included.

The table provides an interesting comparison of the most essential values for Calder Hall and Hinkley Point. The latter is the largest nuclear power station and the ratio of the increase in its values over those for Calder Hall is shown in the last column of Table IV.

Table IV.—CALDER HALL AND HINKLEY POINT

		Unit	Calder Hall A and B	Hinkley Point	Ratio
(a)	Total heat rating of reactors	MW(H)	360	1972	5·478
(b)	Heat rating of each reactor	MW(H)	180	986	5·478
(c)	Total gross generating capacity	MW(E)	92	660	7·173
(d)	Total net electrical capacity	MW(E)	70	561	8·015
(e)	Net station thermal efficiency	%	21·5	26	1·21
(f)	M.C. rating of each main turbine	MW(E)	23	93·5	4·064
(g)	Weight of fissile material of each reactor	Tonne	130	370	2·846
(h)	Mean fuel rating	MW(H)/ Tonne	1·385	2·665	1·916

The expected improvements at Hinkley Point relative to Calder Hall are particularly interesting. The net station thermal efficiency is 21% higher and the mean fuel rating expressed in MW (H) per tonne natural uranium is increased by 91·6%.

4. Detailed particulars of graphite-moderated gas-cooled reactors

This information is summarized in Table VI which indicates the remarkable advance in design. On examining this table more closely one finds, relatively to the Calder Hall prototype, that the following increases in heat rating, dimensions, weights and performance have been achieved:

(a) The heat rating of each reactor from 180 to 986 MW(H).

(b) The weight of natural uranium in each reactor from 130 to 370 tonne

(c) The total number of fuel elements per reactor from 10,176 to 36,000

(d) The nominal core diameter from 37 ft to 49 ft

(e) The nominal core height from 21 ft to 25 ft

(f) The total weight of graphite moderator per reactor from 1146 to 2150 ton

(g) The maximum temperature of fuel 752° to 806°F

(h) The outlet gas temperature at the reactor from 637° to 745°F

(i) The inlet gas pressure at the reactor from 100 to 185 psig

(j) The mean fuel rating from 1·385 to 2·665 MW(H)/tonne.

It is of special interest to note that the dimensions of the fuel elements, the control rods and the fuel channels are practically the same as those of Calder Hall, the differences being minute. The increase in the inlet gas pressure at the reactor enables a much greater mass flow to be obtained.

The material of the cans for the fuel elements is magnesium alloy. For Calder Hall Magnox—C is used and for the others Magnox—A12. A critical factor in the operation of nuclear power stations is the efficiency of heat transfer between the cans and the coolant in the reactor. At Calder Hall the fins were arranged axially and machined from the solid, but a more economic method is to produce them by the extrusion process. The cans used for the reactors at Berkeley, Bradwell, Hunterston and Hinkley Point are made from "Integron" tubing, which is finned helically. These are produced by a process similar in many respects to thread rolling.

Table V.—ESSENTIAL PARTICULARS AND PERFORMANCE DATA OF BRITISH NUCLEAR POWER STATIONS

1	2 Nuclear power station	3 Unit	4 Calder Hall A and B	5 Berkeley	6 Bradwell	7 Hunterston	8 Hinkley Point
1	Year of commissioning		1956/58	1960/61	1960	1961	1962
2	Total heat rating of reactors	MW(H)	360	1100	1060	1060	1972
3	Total generating capacity	MW(E)	92	320	389·5	360	660
4	Total net electrical capacity	MW(E)	70	275	300	320	561
5	Net station thermal efficiency	%	21·5	—	—	28·8	26
6	Total number of reactors		2	2	2	2	2
7	Total number of heat exchangers		8	16	12	16	12
8	Total number of circulators		8	16	12	16	12
9	Total number of main turbines		4	4	6	6	6
10	Total number of auxiliary turbines		—	—	3	—	3
11	Number of heat exchangers per reactor ...		4	8	6	8	6
12	Number of circulators per reactor		4	8	6	8	6
13	Number of main turbines per reactor ...		2	2	3	3	3
14	Number of auxiliary turbines per reactor (one a spare)		—	—	1		1
15	M.C. rating of each main turbine	MW	23	80	52+5%	60	93·5
16	M.C. rating of each auxiliary turbine ...		—	—	20·5	—	33
17	Heat rating of each reactor	MW(E)	180	550	530	530	986
18	Weight of fissile material in each reactor ...	Tonne	130	250	240	251	370
19	Mean fuel rating in MW heat per tonne ...	MW/ Tonne	1·385	2·201	2·209	2·11	2·665

Such tubes are made by Imperial Chemical Industries Limited under licence in accordance with patents held by the Wolverine Tube Division of Calumet and Hecla Inc., U.S.A.

5. Particulars of the reactor vessels

The dimensions, thicknesses, maximum internal pressures, weights and also information on the biological concrete shield are indicated in Table VII. The largest sphere is 70 ft dia (Hunterston), the maximum internal pressure 200 psig and the thickness 3 in. (Hinkley Point). The biological shield varies from 7 to 11 ft thick. The maximum weight of a reactor vessel is 1700 ton at Hinkley Point.

Table VI.—DETAILED PARTICULARS OF GRAPHITE-MODERATED GAS-COOLED REACTORS

1	2 Nuclear power station	3 Unit	4 Calder Hall A and B	5 Berkeley	6 Bradwell	7 Hunterston	8 Hinkley Point
1	Heat rating of each reactor	MW(H)	180	550	530	530	986
2	Weight of fissile material (natural uranium) in each reactor	Tonne	130	250	240	251	370
3	Number of fuel element channels		1696	3000	2620	3288	4500
4	Number of fuel elements per channel		6	—	8	10	8
5	Total number of fuel elements		10,176	—	20,960	32,880	36,000
6	Diameter of fuel channels	in.	3·61 to 4·16	—	—	—	3·75
7	Pitch of fuel channels	in.	8	8·16	8	8·25	7·75
8	Diameter of rods of uranium	in.	1·15	—	1·15	1·15	1·125
9	Length of rods of uranium	in.	40	—	36	24	36
10	Total length of channels	ft	20	—	—	—	—
11	Number of control rods		112	—	120	150	—
12	Diameter of control rods	in.	2	—	—	2	—
13	Diameter of control rods channels	in.	3·25	—	—	3·5	3·75
14	Length of control rods	ft	—	—	—	21	—
15	Nominal core diameter	ft	37	42	40	44½	49
16	Nominal core height	ft	21	24	25½	23	25
17	Diameter of graphite moderator	ft	37	—	—	—	—
18	Height of graphite moderator	ft	27	—	—	—	—
19	Total weight of graphite moderator per reactor	ton	1146	2000	1910	2150	2000
20	Overall size of moderator across corners inclusive reflectors	ft	36	48	45	50½	—
21	Height of moderator inclusive reflector	ft	27	30	31	28	25
21a	Number of sides of moderator polygon		24	32	24	—	24
22	Weight of each reactor	ton	1200	—	—	—	—
23	Maximum temperature of fuel	°F	752	—	—	800	806
24	Inlet gas temperature at reactor	°F	284	—	358	400	—
25	Outlet gas temperature at reactor	°F	637	—	734	745	—
26	Gas temperature rise at reactor	°F	353	—	376	345	—
27	Inlet gas pressure at reactor	psig	100	125	130	150	185
28	Outlet gas pressure at reactor	psig	—	—	—	145·8	180·55
29	Gas pressure drop in reactor	psi	—	—	—	4·2	4·45
30	Heat release from each reactor	MWD/ Tonne	3000	—	3000	2500	—
31	Mean fuel rating	MW/ Tonne	1·385	2·201	2·209	2·11	2·665
32	Number of gas ducts per reactor (inlet/outlet)		4/4	8/8	6/6	8/8	—
33	Diameter of gas ducts	ft	4½	5	5	5	—

Table VII.—PARTICULARS OF THE REACTOR VESSELS

1 Item	2 Nuclear power station	3 Unit	4 Calder Hall A and B	5 Berkeley	6 Bradwell	7 Hunterston	8 Hinkley Point
1	Heat rating of each reactor	MW(H)	180	550	530	530	986
2	Shape of pressure vessel		cylinder	cylinder	sphere	sphere	sphere
3	Diameter of pressure vessel	ft	37	50	66·5	70	67
4	Overall height of pressure vessel	ft	60	80	—	—	—
5	Thickness of material	in.	2	3	3	2⅞	3
6	Maximum internal pressure	psig	100	125	147	150	200
7	Weight of vessel	Ton	—	1000	1100	1000	1700
8	Thickness of biological shield (concrete)	ft	7–8	8·5–10	9–10	9–10	7–11

Chronological Survey of the Principal Researches and Developments on Atomic and Nuclear Energy (1803–1958)

The main object here is to summarize concisely the outstanding researches, the notable developments and the major advances in atomic and nuclear physics which ultimately had the desired effect of generating electrical power on a large scale from nuclear energy. It is hoped that those in search for such general information will find the following survey most useful.

1803 Table of atomic weights published by John Dalton (1766-1844), founder of the atomic theory.

1895 Röntgen or X-ray discovered by Wilhelm Konrad von Röntgen (1845-1923). Awarded the Nobel Prize in 1901.

1896 Radioactivity discovered by the French Physicist Antoine Henri Becquerel (1852-1908). Awarded the Nobel Prize in 1908.

1897 Electron within the atom discovered by Joseph John Thompson (1856-1940), director of the Cavendish Laboratory, Cambridge.

1898 Radium isolated from pitchblende by Pierre (1859-1906) and Marie Curie (1867-1934). Received jointly the Nobel Prize in 1903, and Madame Curie for her own researches in 1911. She gave her name to the curie, a unit radium emanation. One curie is the amount of radioactivity produced by one gramme of radium.

1903 Suggestions made by Ernest Rutherford (1871-1937) and Frederick Soddy (1877-1956) that radioactivity disintergration results in changes of the atomic species.

1905 Relation between mass energy announced by Albert Einstein (Switzerland, 1879-1955) who defined it by the simple expression

$$E = mc^2$$

where E = energy
m = mass
c = velocity of light

The expression indicates that a small amount of mass is equivalent to a large amount of energy.

1911	Atomic nucleus hypothesis pronounced by Ernest Rutherford (1871-1937) whilst Professor of Physics at Manchester University. He concluded that atoms of matter must consist of a concentrated central nucleus surrounded by a swarm of electrons.
1913	The stable isotopes discovered by J. J. Thomson, (1856-1940), Cavendish Professor of Experimental Physics, Cambridge.
1914	Cosmic rays discovered by V. F. Hess, (Germany).
1919	First news of the splitting of the atom announced by Rutherford. His investigations into nuclear reactions were carried out at the Cavendish Laboratory, Cambridge.
1928	Geiger—Müller counter invented by H. Geiger and W. Müller (Germany). The former worked under Rutherford at Manchester University (1907-1919).
1932	John D. Cockcroft and E. T. S. Walton produced the first nuclear transmutation, using artificially accelerated particles. Awarded Nobel Prize in 1951.
1932	The neutron discovered by J. Chadwick.
1932	Deuterium (D_2O), heavy water, discovered by H. L. Urey, F. G. Brickwedor and G. M. Murphy (U.S.A.)
1934	Enrico Fermi (1901-1954), Italian born physicist, discovered the efficacy of slow neutrons in effecting nuclear transformations.
1939	Nuclear fission discovered by O. Hahn, (Germany, Nobel Prize in 1944) and F. Strassman. Practicability of atomic power. Self propagating reaction called "chain reaction".
1941	Plutonium separated at Chicago from uranium by bombardment with neutrons.
1942	First self-sustaining chain reaction pile by E. Fermi operating at Chicago on December 2. First nuclear furnace to produce heat. The birth of the nuclear age.
1945 (Aug. 9)	Bomb dropped on Hiroshima.
1946 (Jan.)	J. D. Cockcroft appointed director of the Research and Experimental Establishment at Harwell (Berkshire).
1946 (Jan. 29)	Atomic Energy Production Organisation set up. Headquarters at Risley, near Warrington.
1946 (April)	Work started at Harwell.
1947 (Aug. 15)	First reactor "Gleep" (Graphite Low Energy Experimental Pile) started up at Harwell. Natural uranium as fuel. Air cooled, 100 kW.
1947 (Sept.)	Work started at Windscale, Cumberland, on plutonium factory occupying about 300 acres (two reactors).
1948 (July 5)	Reactor "BEPO" (British Experimental Pile Operation) started up at Harwell. Natural uranium as fuel. Air cooled, single pass, (180,000 cu ft/min).
1950 (July)	First reactor started up at Windscale. (Natural uranium, graphite moderated, air cooled).
1951	Second reactor started up at Windscale.
1953 (Aug.)	Work started on Calder Hall Power Station.
1954 (Feb.)	"ZEPHYR" (Zero Energy Fast Reactor) operated at Harwell for fast reactor studies.
1954 (July)	United Kingdom Atomic Energy Authority (U.K.A.E.A.) set up.
1954 (Aug.)	"DIMPLE" (Deuterium Moderated Pile, Low Energy), started up at Harwell for thermal reactor studies.
1955 (Feb.)	Government White Paper, "A Programme for Nuclear Power", published.
1955	Work started on construction of experimental fast breeder reactor at Dounreay in Caithness.
1955 (March)	Engineering firms pool resources to study problem of atomic power stations.
1955	"ZEUS" (Low Energy Breeder Pile) started up at Harwell to study a particular core design for the fast reactor at Dounreay.
1955	Work commenced on nuclear power station at Chapel Cross, near Annan, Dumfriesshire.
1955 (Aug.)	Geneva Conference, "Peaceful uses of Atomic Energy".
1955	"ZETR" reactor started up at Harwell to study physics of homogeneous aqueous systems.
1955 (Oct.)	Sites for nuclear power stations Bradwell (Essex) and Berkeley (Gloucester) selected.
1956 (May)	Calder Hall Reactor No. 1 started experimentally.
1956 (Oct. 17)	Calder Hall Power Station officially opened by the Queen.
1956 (Dec.)	Central Electricity Authority placed contracts for the following nuclear power stations: (1) Berkeley (Gloucester) (2) Bradwell (Essex) (3) Hunterston (Ayrshire).
1957 (April)	Reactor No. 1 of Calder Hall–A discharged to bring temperature in line with design. Refuelled and restarted.
1957. (April)	Reactor No. 2 of Calder Hall–A in operation.
1957 (Aug.)	Fifth nuclear power station site selected in Merionethshire at Trawsfyndd, twelve miles from Dolgelley. 400 to 500MW (electric) plant to be in service in 1962.
1957 (Aug.)	Commissioning test on "ZETA" (zero-energy thermonuclear assembly) started at Harwell. Values of 5,000,000°C recorded. Exploring the possibility of producing power from the fusion or joining of light atoms, such as those of hydrogen.
1957 (Sept.)	Central Electricity Authority placed the contract for the fourth nuclear power station, 500MW (electric) at Hinkley Point, Bridgwater Bay, Somerset, to be in operation in 1962. Total cost £60 million.
1957 (Oct.)	Accident to No. 1 pile at Windscale on the 10th. Consequently No. 2 pile shut down on October 18.
1957 (Nov.)	Zero-energy reactor "NEPTUNE" became critical on the 12th. An experimental pressurized water enriched uranium reactor for submarine propulsion
1958 (March)	No. 1 reactor of Calder Hall—B and the two turbogenerators started up on the 12th.
1958 (May)	American atomic submarine *Skate* remained submerged for 31 days.
1958 (June)	Explosion of the 23MW turbogenerator No. 2 at Calder Hall-B on the 28th. Failure due to overspeeding as a result of the governor emergency valves not closing instantaneously. Cause given as fragments of chilled shot in steam line.
1958 (Aug.)	American nuclear-powered submarine *Nautilus* went submerged under the North Pole on 1st, and remained 96 hr. Submerged at Point Barrow, Alaska and emerged between Greenland and Spitzbergen. Covered 1830 nautical miles at 20 knots at a depth of 400 ft.
1958 (Aug.)	American atomic submarine *Seawolf* submerged on the 7th and remained under water for 60 days and travelled 15,700 nautical miles. A mileage of 65,000 had been done with the first nuclear core.
1958 (Oct.)	Decision made by U.K.A.E.A. to seal off No. 1 and No. 2 pile at Windscale. These were started up in July 1950 and 1951 respectively. The fuel to be discharged and reprocessed.
1958 (Oct.)	Sixth nuclear power station of 650MW (Electric) to be sited at Sizewell, near Leiston, East Suffolk.
1958 (Oct.)	Advanced gas cooled reactor planned for Windscale and to be known as "A.G.R." It is experimental in the direction of higher temperatures and fuel ratings. Designed to give 100MW (heat) and 28MW (Electric). Contract for heat exchangers placed on November 4.
1958 (Nov.)	The first of four reactors at Chapel Cross started work on November 9th. Expected to be on full load end of January, 1959.
1958 (Dec.)	No. 4 reactor at Calder Hall started up on the 8th December.

Anti-scuffing Spray

A quick, handy method of applying a hard bonded molybdenum disulphide lubricant film to metal or plastic surfaces has been developed by Rocol Limited, Ibex House, Minories, London, EC3, in the form of an aerosol pack.

The spray contains a basis of molybdenum disulphide of particle size suitable for surface treatments, and bonding resin to effect retention of a film, plus a propellant. The vapour is non-toxic, non-corrosive and not offensive to operators. It is recommended as a means of providing quick assembly lubrication or intermittent dry lubrication; for example, the treatment of moulds, dies and press working tools which need replenishment of parting compounds without dismantling the equipment.

Retention of Inserts in the Plane of the Die Parting

The use of cast-in-place inserts in diecastings necessitates the interruption of the casting cycle for the positioning of inserts. Dies for insert-bearing components must accordingly provide for the safe loading, correct location and secure retention of the inserts. When these are located in the parting plane special problems arise in all these regards, and are discussed

By HIRAM K. BARTON

THE use of inserts to confer especially favourable properties upon a localized portion of a diecasting is a practice nearly as old as the industry; the commonest type of insert is a short length of steel rod, often bearing a screw-thread, and with one end firmly held by the metal of the diecasting as on the left of Fig. 1. In default of the insert, the diecasting would need to be provided with a slender integral stud, threaded or otherwise, as on the right of the figure. The insert provides vastly greater strength, particularly in respect of impact loads, whilst threaded inserts are more resistant to stripping when repeatedly slackened and tightened than are cut threads on an integral stud.

The main function of inserts of this sort is to allow the attachment of some other component to the diecasting, or to permit the securing of the diecasting itself to a larger unit. Since most diecastings that bear inserts are flat or shallowly dished, the great preponderance of inserts is accordingly orientated normal to the main plane of the component and, hence, in most cases normal to the die parting. This greatly simplifies both the problem of getting the insert into the die, and that of getting the casting out again with the insert in position. The ease with which inserts can be located correlates closely with the speed at which the die operates, so that this point has an immediate effect upon the efficiency of production.

Location of inserts normal to the parting plane can be facilitated by the use of various sorts of loading device and can, indeed, be made completely automatic. It is less easy to provide equivalently effective means of loading inserts in the plane of the parting short of fitting a magazine feed, and this is suited only to inserts in the medium size range—say from one to four inches in length and from one-quarter to half-an-inch in diameter or across flats. Inserts smaller or larger are frequently difficult to handle in normal commercial practice—that is, using standard jobbing equipment—though special-purpose machines cope with them readily enough if the quantities justify such equipment.

It is proposed to consider here, however, only the problems arising out of the location of large inserts in dies for which relatively short runs are expected and which, therefore, do not warrant the construction of any elaborate loading devices. If the insert is large enough, of course, the problem solves itself; a portion can be left projecting from the die to form a handle. All that is then necessary is to provide a safety lock that will prevent the injection of metal or, less satisfactorily, the escape of metal, should an insert be inadvertently omitted.

The mechanical portion of such a device is now almost always of the construction seen in Fig. 2, where a strongly spring-loaded hollow steel bolt is housed in the fixed die member and in its free position projects some way from the face. The axis of the bolt transects the insert seating; in consequence, when an insert is correctly positioned the end of the bolt contacts it prior to closure. The insert is thus held in position during the last part of

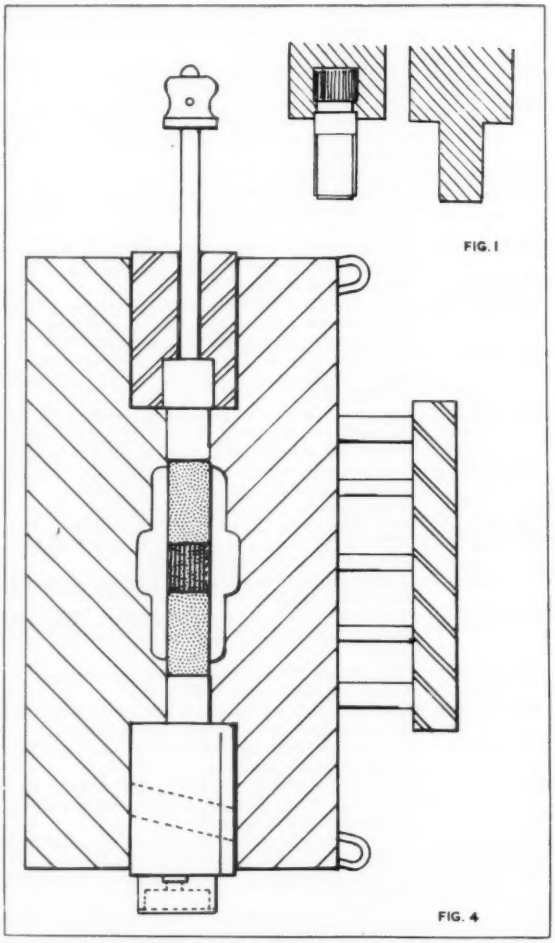


Fig. 1.—The use of steel inserts (left) instead of integral studs provides a valuable accession of strength at highly-stressed locations; integral studs as on the right are more likely to fracture under shock loads. Fig. 4.—The tool in closed position, with the insert held between two blocks operated by finger-cams. A light spring detent, not shown in the figure, prevents the guide-pin from falling on the opening stroke of the die

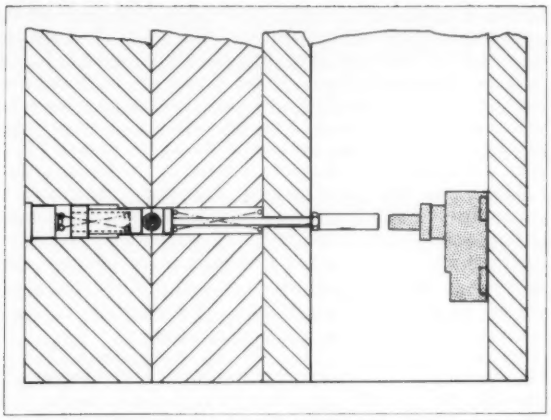


Fig. 2.—If the insert, here shown in position, is omitted by the operator, the spring loaded bolt on the left forces back a light plunger and actuates the limit switch (shown stippled on the right) before closure has been completed

the stroke, the bolt being forced back in its housing as on the left of the figure.

Should an insert have been omitted, the bolt is not forced back but enters a matching recess in the moving die member, thus blocking off the inner part of the insert seating. This of itself prevents the escape of metal, but it is desirable in the first instance to prevent injection of metal, if this is practicable. One method of achieving this, adapted to machines in which the operating cycle is electrically controlled, is indicated in the figure. A counter-plunger, only lightly spring-loaded, is housed in the moving die member and carries a slender spigot projecting through the rear of the die-block.

A limit switch is positioned in the ejector-box, either in front of or behind the ejector-plate. If the latter, the spigot is extended to pass through a clearance hole in the plate. The limit switch button is aligned with the plunger but there is normally an eighth of an inch or so clearance between them, and since the counter-plunger does not quite reach to the insert seating, the presence of an insert does not affect the mechanism. However, if an insert be omitted, the safety-bolt pushes back the counter-plunger and actuates the switch; this is looped into the control circuit and arrests the movement of the tool before closure is completed.

This is advantageous because, if the actuation of the switch was due to the displacement of an insert from its seating rather than its omission altogether, damage to the tool by the crushing of the insert between the die faces is prevented. The method here shown is, on the whole, preferable to the alternative of locating the safety-bolt in the moving die member. Occasionally one sees tools so constructed, these being in direct descent from hand-operated dies in which the insert was usually positioned in the fixed member, and in which the action of the spring-loaded bolt was purely a mechanical one.

In electrically, or electronically, controlled machines the mounting of the bolt in the moving member rather complicates the circuit, since the bolt (which now has to carry the spigot or operating finger since the switch must still be at the back of the moving member) moves backward and forward at each cycle. Thus it is necessary to switch out the main die-advance loop a little before closure, leaving the parallel safety-switch loop to complete the movement if, and only if, the correct placement of the insert has resulted in the safety-bolt having been

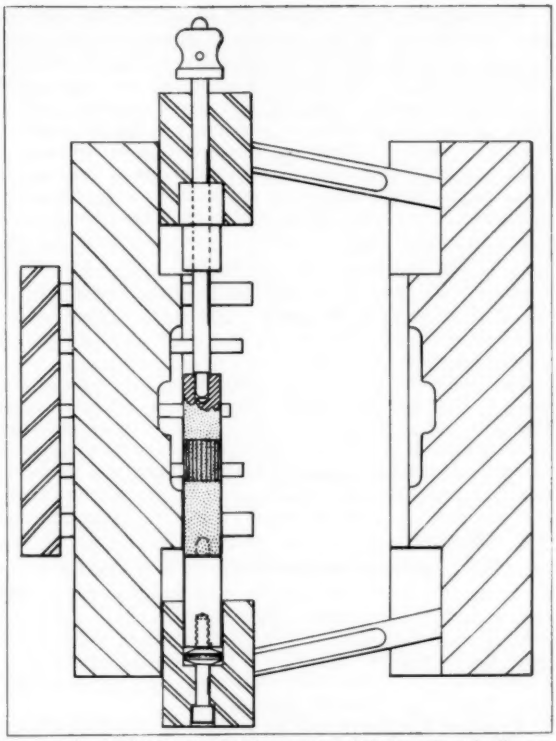


Fig. 3.—A loosely-sliding guide-pin is here used to hold the heavy insert in alignment during die closure

forced back. But this is more complicated than the method described above.

It is possible, by more or less elaborate linkages, to utilize the movement of a safety-bolt to control the actuation of the injection lever itself on manually-operated machines; the general principle is to arrange for the correct movement of the bolt to withdraw a pin or ratchet that is immobilizing the hand-lever. Apart from tendency to fail, or fall to pieces, such mechanical methods have the disadvantage of being specific to a single tool. A simpler and more effective device is the actuation of a buzzer when closure is occurring without an insert in position.

If the insert is wholly contained by the tool there is at least no danger of metal escaping along the seating should an insert be omitted, but it is still highly important that the insert should not easily be displaced from its correct position in the die; this, of course, is less easily checked when the end of the insert does not protrude beyond the die edge. An additional factor now to be considered is that of the operator's personal safety, since manual placement of inserts in the open die constitutes something of a hazard in semi-automatic machines.

If the projection of the insert beyond the edge of the cavity is substantial, the difficulty can be avoided by using some sort of loose insert-holder into which the insert can be placed while the holder itself is clear of the die. The most satisfactory form of holder, provided that the insert is of plain cylindrical form, is a quill mounted in a sliding block that is completely demountable from the main die. The block should be furnished with an adequate hand-grip and should be kept as small and light as possible.

It is usually most satisfactory to extend the quill so that it closes the cavity, and this is essential if the insert has an enlarged head. Occasionally the quill may be used to form the end-face of a boss and can, of course, incorporate surface features just like a normal sliding core. Unless the position of the insert in the die ensures that it is held in correct casting position by gravity, a light detent of some sort is advantageous in preventing axial displacement. However, the use of a detent bearing upon the side of the insert makes it impossible to cast the component without inserts when warming up the tool at the beginning of a shift, and it is accordingly necessary to provide a duplicate sliding block with a blank plug instead of a quill. This is preferable to the wedging of a cut-down insert into the normal holder, a practice sometimes resorted to.

The greatest difficulties in insert location undoubtedly arise in the case of massive inserts that, whilst passing right through a component, project only a small distance at each end. It is almost always necessary to align such inserts between two opposed sliding blocks, but since the depth of engagement in each is small, there is no advantage in making either of them removable from the die. The difficulty encountered in operation—even in the most favourable case, when the cavity is orientated so as to bring the insert vertical—is that a slight tilt of the insert during die closure prevents its upper end from finding the opposed seating, so that the edge of the latter becomes burred and chipped. If the misalignment should be marked, the whole mechanism is badly strained and one of the finger-cams is likely to fail.

To avoid these very serious disabilities calls for a more complex construction of the sliding blocks, but this necessary elaboration is least when an axial service hole is allowable in one or both ends of the insert. With this modification to the insert, it is only necessary to provide the upper, or the near-side, insert holder with a free-sliding guide-pin concentric with the seating as in Fig. 3. This pin is long enough to project from the die at all times. With this addition to the tool, the operator places the insert in the lower holder in the usual manner, and then pushes down the guide-pin until it enters the service hole in the top of the insert. The upper insert-holder remains in its withdrawn position. The tool now being closed, the guide-pin keeps the insert in alignment as the opposed holders come together; the insert rises on the lower holder into correct casting position as seen in Fig. 4.

It is desirable whenever an insert is held endwise between two die elements to make some provision for variation in insert length, by providing a spring-loaded pad against which one end may butt. In the tool of Fig. 3 such a spring-loaded support is fitted to the lower insert-holder. It is only necessary for a device of this sort to allow for a small overall variation—possibly $\frac{1}{32}$ in. either way—since manifestly overlength inserts are detected by the operator and rejected. However, the movement of the pad may advantageously be made greater than this, so that if an insert is omitted the pad is substantially out of position at closure.

By means similar to those of Fig. 2 a microswitch can then be actuated as the die closes completely; in this case the switch is closed if an insert of acceptable length is in place, but remains open should an exceptionally short insert have been used or, of course, if the insert has been omitted. In this tool the likelihood of an insert, once correctly held by the guide-pin, subsequently becoming displaced, is very small. The safety switch may therefore be in the injection control circuit (on gooseneck machines) and if there is no insert the machine cycles over without metal being injected. On cold-chamber machines, where it is rather disconcerting for a charge of metal to be left undisplaced by the plunger in the shot-chamber, the switch should operate a flashing-light signal to warn the operator not to ladle-in metal.

Tubular inserts are readily dealt with in much the same way; in fact, if the ends project from the component a tool exactly like that of Fig. 3 suffices, the guide pin suiting the interior diameter of the tube. If the insert is to be wholly shrouded in the casting it is necessary to locate it upon split spigots slightly sprung to fit tightly into the tube. The spigot on the lower core should be long enough to assure correct alignment, since no guide can be provided in the top one. However, the ends of the spigots can be given plenty of lead, though they must be a good fit in the tube at the base in order to prevent the ingress of metal. One or both of the spigots should be vented, for air escaping from within the hot insert may otherwise cause blow-holes at the junction of insert and core.

Mechanical Engineering Research

Notes on work at MERL

Measuring the air content of oils

AIR dissolved or entrained in hydraulic oils causes loss of efficiency in positive-displacement pumps, longer pressure build-up times in hydraulic presses, and instability in hydraulic servo-systems. To help in finding out more about these effects, a simple, robust device has been developed for measuring the air content of a sample of oil in a few minutes. It is suitable for works' use and is now being manufactured commercially by F. W. Baggett & Company Limited, 8 Temple Street, Wolverhampton, under licence from the National Research Development Corporation, who hold the patent rights.

The apparatus consists of a steel cylinder in which there is a cage filled with steel balls. A steel sample-bottle, taking a standard volume of oil, is screwed into the bottom of the cylinder. The sample-bottle is isolated from the main cylinder by a weight-loaded valve. The cylinder is evacuated with a vacuum pump and is then inverted so that the valve opens automatically. The oil sample is thus subjected to a sudden reduction in pressure and spreads as a thin film over the steel balls. Their large surface area helps in releasing all the air very rapidly. The increase in pressure in the chamber, measured with an ordinary vacuum gauge, is a measure of the air content of the oil. *MERL Fluids. Note No.* 47.

Strength of pin-joints

Tests on a particular type of pin-joint have shown that it can be made eight times as strong by using an interference fit for the pin in place of the original sliding fit.

The simplest type of pin-joint—a fork and tongue held together by a pin or bolt passing transversely through the assembly—is important, particularly in aeroplane construction. Direct-stress fatigue tests have been made on a high-strength aluminium alloy tongue with a hardened steel pin to improve its load-carrying capacity and to find out more about the factors which should be considered by designers. The fatigue strength

of the original design was found to be much less than the theoretical value: this is thought to be due to fretting corrosion between pin and tongue.

The effect of different sizes of pin and different degrees of interference have been investigated. With a tongue 2¼ in. wide and ¾ in. thick, the best size of pin is 1 in. dia and the best interference, for long life, is 7 thousandths of an inch.

Tests are also being made on joints assembled with a sliding-fit pin in an interference-fit bush; a similar improvement in strength was obtained. These should be suitable for joints which have to be dismantled and reassembled from time to time.—*LOW, A. C. The fatigue strength of pin-jointed connections in aluminium alloy B.S. L65. Proc. Inst. Mech.E. preprint.*

Measurement of large water flows

Four methods of measuring the rate of flow of large quantities of water in pipes have been tried simultaneously in a 40 in. pipeline at flow rates up to 27,000 gpm. The tests have given useful information about the relative accuracy and convenience of use of each method under field conditions. These measurements supplement earlier laboratory work during which new equipment and techniques were developed and the errors inherent in each method determined.

With current-meter and pitot-tube methods the bulk flow is obtained from measurements of the local velocity at specified points across a section of the pipe. By selecting these points in a new way the flow rate can be obtained from measurements at fewer points than standard methods, with at least as great an accuracy in the final result. Current meters are small propellers mounted on low-friction bearings: their speed of rotation depends on the local velocity. Electronic equipment has been developed for automatically recording the number of revolutions, in a known time, of up to 21 current meters. The flow rate can then be calculated within a few minutes of the measurements being taken.

Salt-velocity and salt-dilution methods give the mean flow directly. In the salt-velocity method a quantity of salt solution of higher electrical conductivity than that of the water is suddenly injected into the pipeline and its passage is timed between two downstream positions a measured distance apart. Improved injection gear and detecting electrodes have been developed. In the salt-dilution method a salt solution of known strength is pumped continuously into the pipe at a steady rate. Samples are taken at a downstream position where mixing is complete and their concentration is compared with that at the injection point. With this method the dimensions of the pipe do not have to be measured.

In these field tests the new equipment was tested and the accuracy of each method was determined relative to the current-meter method, which was used as the reference. Most of the results from the other three methods were within $\pm 2\%$ of the current-meter values—*MERL Fluids Report No. 65.*

Design of hydraulic relief valves

A promising method is being developed to provide hydraulic engineers with the basic data needed to design relief valves with a given performance.

A relief valve should open at a pre-set pressure, it should open as quickly as possible without imposing shock loads on the circuit, and it should not oscillate and cause noise while it is open. Tests on eight commercial valves showed that the circuit in which the valve is used has a very marked effect on its characteristics. Under the test conditions none of these valves met all the above requirements satisfactorily.

The method being tried out at MERL is to simulate electrically the characteristics of the components of a hydraulic circuit. For example, the orifice of a valve can be considered as a resistance, and the mass of fluid above the valve piston as an inductance. Calculations have been carried out for the electrical equivalent of a simple, but typical circuit consisting of a supply tank, a positive-displacement pump, and a flow-control valve, with the relief valve between the pump and the control valve. The circuit equations indicate whether the valve is adequately damped and give the correct stroke for a given rate of flow; the response time of the circuit can also be derived.

Measurements on this type of hydraulic circuit have confirmed that this electrical analogy method gives valuable guidance to the designer. The method is being developed to cover more complex circuits.—*MERL Fluids. Note No. 53.*

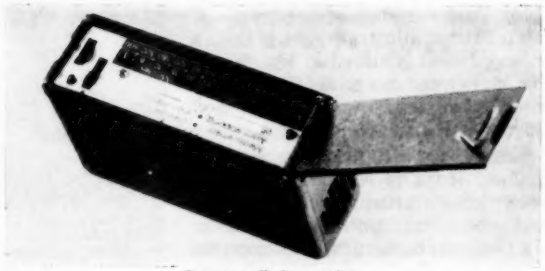
The notes and reprints referred to above are available from the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

Audible Warning of Gamma Radiation

A new warning device of the ionisation chamber type which gives a loud warning on receiving a beta or gamma dose of 30 milliroentgens is now available in a portable battery operated form.

The instrument which weighs 12½ oz uses transistors and is also suitable for outdoor operation in temperate climates. The batteries have a capacity of 220 mAhr and as they are discharged only during the emission of the signal and no current is drawn during measurement, they provide for 2-3 months' operation under normal conditions. They are recharged *in situ* by means of a small mains operated charger which weighs only a few ounces and can be plugged into the instrument. The monitor developed by Radiation, 7 Sheen Park, Richmond, Surrey, has a flat response to radiation energies ranging from under 100 kV to 3 megavolts.

Although the maximum permissible radiation for operators working a 40 hr week is approximately 6 mr/hr, for special operations personnel may be intentionally exposed to a greater dose rate for limited periods. The dose of 30 mr represents approximately half the maximum daily dose permissible for a worker engaged on radiation work. It also corresponds to the maximum weekly dose at present permissible for other personnel employed in the area. A small beta source normally housed in a lead-lined container is used to check correct operation of the instrument by placing it in position on the monitor. For this a stop watch and a calibration sheet supplied with each instrument are used.



Gamma radiation monitor

technique

—devoted to the discusssion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Clipping Tool for a Shallow Cup

Cupping is not a process likely to create many problems because generally the operation merely consists of blanking a disc to the required diameter and pushing it straight through a die where it will fall into a receptacle. However, shallow cups, i.e. relatively large in diameter in relation to depth, and where the depth is held to a close tolerance, demand a careful treatment and an entirely different design of tool is desirable. Fig. 1 illustrates a typical example where close limits are required, and with thin material the possibility of trimming the edge during pressing requires consideration as this eliminates another handling and so reduces costs.

The material is fed through the tool in the conventional manner, but on this occasion the width of the strip is made slightly greater than is necessary because a small flange is made in the cup which is afterwards removed as a narrow scrap ring.

The tool as depicted in Fig. 2 has completed the downward stroke and severed the scrap section of metal, but initially the strip is fed mechanically and a scrap cutter reduces the punched strip to short lengths after it has passed the die. However, after correct positioning over the die A, the punch B severs a disc and holds it between the cutting surface and the face of the lower pressure ring C. The latter, incidentally, is operated by the pins D which pass through the bolster E to contact the pneumatic cushion. Continued movement of the ram draws the disc over the lower punch until almost all the material is withdrawn from between the punch and the pressure ring, and at this stage the flanged shell is flush with the cutting edge of the member G.

To further illustrate this point an enlarged view is added at Fig. 3, and this shows the lower detail G ready to shear off the unwanted edge and leave a perfectly trimmed cup.

Because of the thin material only a small ledge is required from the drawn diameter to the cutting edge, and such a condition makes it easier if a two-part construction as depicted at Fig. 2 is used as this will ensure a sharp cutting edge and a square corner for the cup to seat on, and no undercutting is necessary to clear the grinding wheel. Details F and G make up this simple sub-assembly which, after location, is secured by spigoting one into the other, a long screw passing through and holding them together.

To illustrate the final position of both the upper punch and lower cutting member, an enlarged view is included, Fig. 4, which shows that the scrap has been carried downwards for a further short distance—in practice the distance travelled is probably not so great as that depicted here because the material severs before the punch has passed completely through the sheet.

Once the ring of scrap has been cut off, the press ram commences to rise and the piece is lifted by the ring up to the die level where an air blast can blow it clear of the tool; or it can again enter the hole made by the initial blanking in the strip and as the latter advances this movement will slide it away from the aperture where it can drop away or slide down a chute into a scrap bin. In practice, the former method is preferred as there is then no risk that the strip will override the scrap and leave it still in place in the tool.

The ejection of the cup is not quite so simple, and to make sure that each member is lifted from the punch, a dual form of ejection is utilized. Three or four small but rather stiffly loaded plungers, which are compressed as the top punch descends, act on the cup and commence to lift it from the forming punch, and this movement is further assisted by an air blast passing up through the lower tool. An ejector is also fitted to the upper tool as shown at H to prevent sticking in the forming die; thus there is a tendency for the cup to remain on the lower portion of the tool rather than cling to the ascending die.

An additional feature which is useful when the strip material is greasy, is the plunger K which will break the seal created by the scrap ring sticking to the pressure ring. Generally, with thin metal the scrap falls away without difficulty, but the merest trace of grease makes it hold tenaciously and then stacking commences which is naturally dangerous as this will eventually cause fracturing of either the punch or die. Because the plunger

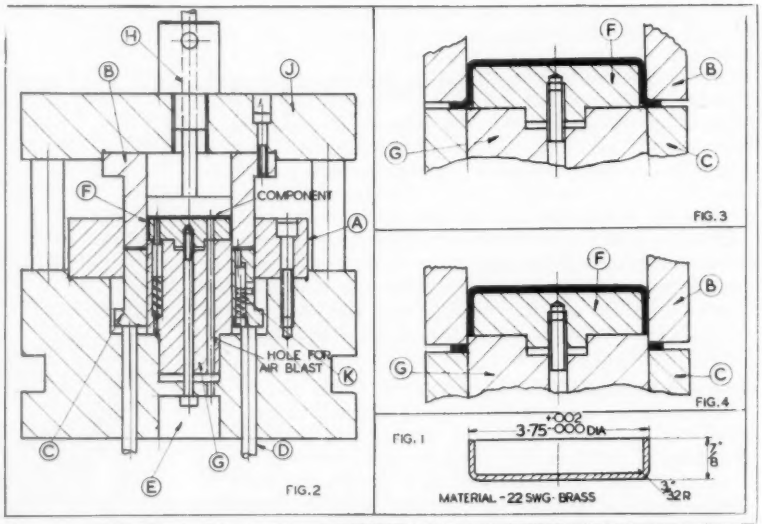


Fig. 1 (bottom right).—Typical shell which can be trimmed in the drawing tool—an operation which is particularly useful when there are close tolerances as shown. Fig. 2 (left).—Tool for trimming the shell with various refinements for ejecting the finished piece. Fig. 3 (top right).—Enlarged sketch illustrating the component just ready for trimming, showing clearly the method of constructing the forming and blanking punch. Fig. 4 (centre right).—The trimming operation is shown here completed and the tool is ready to rise for the ejection of workpiece and scrap

is close to the bore of the pressure ring the plunger end is turned eccentric and a small grub screw prevents it turning; the latter slides in the usual elongated slot milled in the pressure ring, and the spring underneath this is made stiff enough to break the seal between the material and pressure ring. The amount of lift is unimportant and a distance of between $\frac{1}{64}$ to $\frac{1}{32}$ in. is sufficient.

Trimming tools of this type though slightly more costly to manufacture, can nevertheless save tool costs when the quantity of parts makes it necessary to use mechanical feeding for transferring the shells into the tool for a subsequent trimming stage, as the latter are more expensive to produce, and equipment of this type once adjusted to ensure the scrap is properly removed and the shells blown clear, will give an exceptionally high production rate with each article correct to close tolerances—in fact closer than those stated in this example. For these reasons an inclinable press is essential with, perhaps, a stacking device to allow quick removal for the next process.

Production Cutting of Stainless Steel Slabs

A special purpose machine for cutting stainless steel slabs up to 45 in. wide and 6 in. thickness has recently been installed in the Park Works of English Steel Corporation Limited, Sheffield. Made by Hancock & Co. (Engineers) Limited, Croydon, it has a cutting area measuring 27 ft $\times$42 ft making a total of 1134 sq ft, and is very likely the largest oxygen cutting installation in the world.

On the 60 ft long main rails are mounted two driven gantries each spanning 30 ft and giving a cutting width of 27 ft, and on each gantry is a heavy duty driven carriage carrying a pair of large capacity iron powder dispensers and two burners on an outrigger capable of cuts up to 48 in. apart. Each gantry is also equipped with an additional independent non-driven carriage, carrying a single burner.

Services to each driven carriage include oxygen, acetylene, compressed air and electric power cable. These are contained in a stainless steel helix which lies neatly at all times in channels affixed to the side of each gantry and alongside the main rails, coiling and uncoiling smoothly as the traversing takes place.

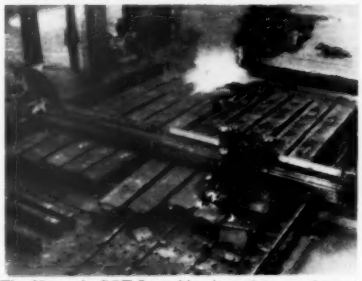
On the driven end of each gantry is a cradle to carry the air driers for the powder dispensers, each with its own pair of driers. At any given time one drier of each pair is in operation and the other is being reactivated. Humidity indicators are fitted and the necessity to switch over to the other drier is indicated by colour change.

The powder cutting attachment on each of the burners is not of the concentric nozzle type but consists of a small diameter tube. When cutting the tube precedes the burner.

In operation the slabs are generally lined up for cutting parallel with the main rails of the machine and all cuts are transverse as the long sides do not normally require trimming. One of the gantries is brought into position over the "ingot head" end and the driven carriage then traverses making two trimming cuts about 20 in. apart, whilst the other gantry is used to remove the "bottoms", all cuts being made simultaneously.

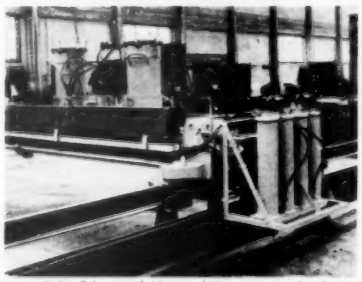
When taking the two trimming cuts the burner nearest the end of the slabs leads slightly to ensure that it completes its cuts before the other burner. Trimming is continued until metal free from ingot head unsoundness is reached and the off-cuts go for remelting. The sound slabs are then severed into lengths of about 6ft.

In three months about 6,000 tons of stainless steel slabs were dealt with. Reckoning on about 30 ft of cutting for each slab this total represents some 15,000 ft of cutting or about $2\frac{3}{4}$ miles.



The Hancock COT I machine in action carrying out trimming cuts at both ends simultaneously on small stainless steel slabs 6 in. thick

Close-up view of one of the driven carriages. A double trimming cut on one slab has just been completed and the machine is about to proceed without interruption to a similar cut on the next slab



View of the driven end of one of the two gantries during construction of the machine. The two pairs of air driers and their humidity indicators can be seen in the foreground. This view also shows the neat hose handling arrangement

Taper Boring Tool

The internal tapering of a hole is not usually difficult provided the reamers or boring tools are available and with a suitable cutting oil an excellent finish is achieved which assembles accurately with the mating. plug. However, occasionally very large jobs come along in small numbers, which makes the cost of special reamers prohibitive, and this factor is often increased when flat blade tools are needed to remove much material from the drilled hole. Taper boring on the orthodox centre lathe is, again, not difficult if the equipment is fitted to the machine, but even then a long hole can present the awkward problem of tool spring at the rear end of a hole and so introduce slight but annoying inaccuracies.

With these facts in mind the production of the long internally tapered component shown in Fig. 1 was undertaken, the machining being carried out on a No. 8 Herbert turret lathe, and as reamers were out of the question, it became necessary to design a boring tool which would not push off as the hole was completed.

Initial thought revealed that the tool needed supporting during the whole time it was cutting to prevent any tendency to push away, and this suggested that the single point style would fill the bill. Again it became obvious that some form of taper attachment to guide the tool was essential together with a linear

motion to give the necessary degree of feed as the tool progressed down the roughly machined bore. It also meant that the tool must pivot in some way, or at least the holder accommodating the tool must have this swinging arrangement.

From all these facts, the tool seen at Fig. 2 was eventually designed, and the main body A is a sleeve type part in which a tapered groove has first been milled, and then finally ground both on the sides and angle to provide a close sliding fit with the tool holder B.

This latter is, in turn, assembled to the shank which is clamped to the front tool box of the turret lathe—a hardened and lapped pin F is sufficient to hold the bar without additional locking nuts, but the use of a small oiler or grease cup is useful to prevent seizure.

Holding of the cutting member proved rather a problem because the diameter fitting the holder is so small together with the shape of the bar it made this difficult and a simple pin driven crosswise through the tool was deemed the most effective way of securing this point.

The remaining item of the assembly is the stop collar D which is mounted on the sleeve A and thus governs the position of the taper relative to the front end of the component. Gaps are milled to allow chips to wash clear and coolant to reach the tool, there is a clearance between the tool bar and sleeve as the holder progresses down the hole that allows the liquid if run over the accessory in large quantities, to contact the cutting edge.

It is necessary to break down the work this tool must undertake, and initially a series of drills passed down the bore to make steps is one way—in fact this method was the one applied because it meant standard drills were employed, and if care in setting is taken, coupled with making a brief sketch to determine the depth, it is possible to set the drill accurately and a surprising amount of material is removed.

Two or three old blade cutters roughly ground to correspond to the angle of taper and attached to the end of boring bars will also help to smooth the bore prior to finishing if they are available, but the lack of such tools means that the finishing tool must machine the hole without them. This is not so great a problem if the drills have completed their task properly, but the point is mentioned because every effort is necessary to reduce the amount of swarf coming off the tool and so ensure a reasonable life between re-grinds.

The first forward movement of the turret slide brings the collar D in contact with the shoulder on the component, and only a light pressure is necessary otherwise there is a risk scoring will take place. The collar

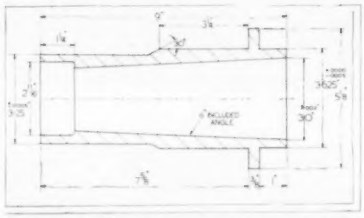


Fig. 1.—Large internal tapers of the type illustrated require tools which are expensive to produce and the quantity of pieces seldom makes the provision of these details an economical proposition

cannot rotate because this prevents swarf from clearing itself or coolant reaching the cutting edge, so if the face of the collar is just allowed to touch the flanged surface this is sufficient.

The tool bar is assembled into the sleeve (this is the rather obvious reason for the length of the latter) and the feed is set in motion. The immediate reaction of the tool is to push away but the pivoting motion is arrested by the end of the tool contacting the back face of the tapered slot, and it is this pressure which is continually exerted throughout the cutting process that ensures the taper being correct. As the hole at the rear end is parallel the cutting process eventually comes to an end—the cut runs off in other words and this means that the trip mechanism to the feed will bring the operation to a standstill.

A forced feed of coolant is essential due to the depth of hole. Pressure injection by normal methods is some assistance, but as the depth increases the rear end can only receive small quantities and it is doubtful whether this is sufficient really to keep the bore clear. A long hole drilled for an oilway or a groove milled in the side wall—on the outside, of course—in which a small bore copper tube is sunk and the slot then re-filled with Cerrobend or similar material, will bring the coolant to the far end and, if necessary, one or two holes drilled to break into the tube and then again plugged on the outside, will allow the oil to run into the tool slot and so lubricate the cutting member.

Carbide tools are recommended due to their great wearing qualities, and on this occasion the shank was silver steel hardened and with the contact end domed and polished.

A tool of this design has other possibilities besides boring a plain tapered hole, and within limitations it should give excellent results. For instance, if either a tapered or parallel bored hole required a series of shallow grooves or protrusions at intervals down the bore, the provision of shallow dimples by means of a drilling machine at the bottom of the tool slot where the shank rubs the groove, will cause the holder to move outwards slightly and so produce the required series of waves at the specified intervals. Similarly by drilling holes at the necessary centres and inserting plugs with domed ends, these can project slightly into the slot and so cause the holder to move inwards thus making annular rings at spacings equal to

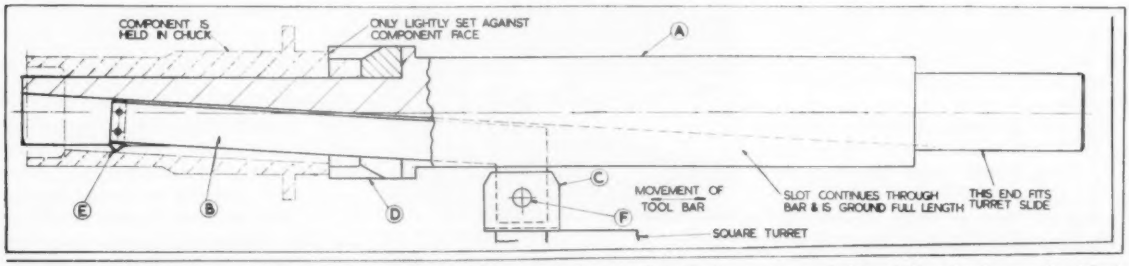
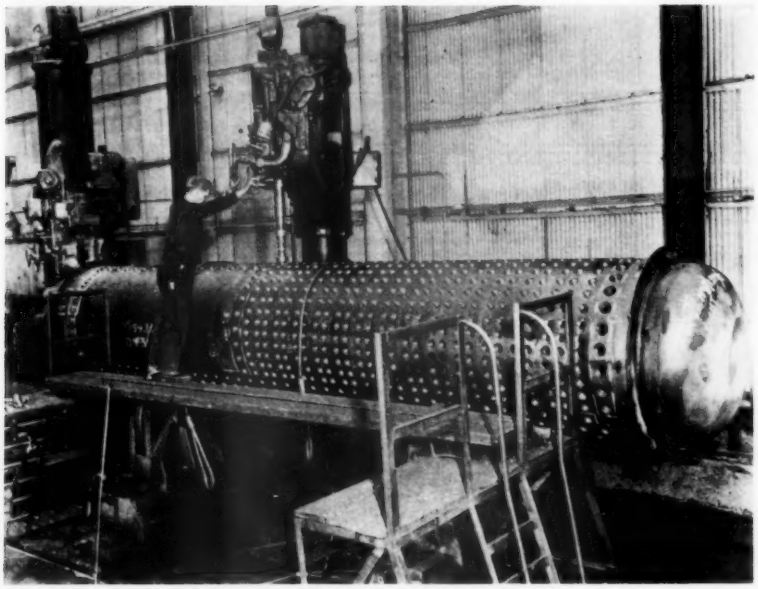
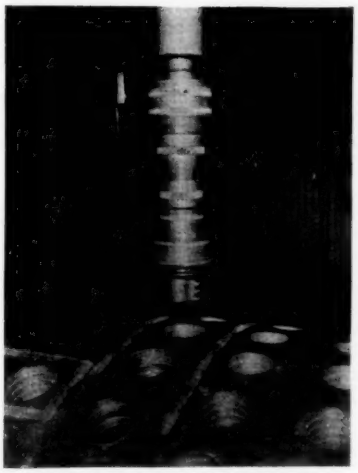


Fig. 2.—This type of boring tool consists primarily of a long shaft in which is machined a tapered slot. Tooling costs are negligible and this makes the operation of boring an attractive method of performing the process





GROOVING BOILER DRUM TUBE HOLES.—This boiler drum in the Renfrew works of Babcock & Wilcox Limited is having the tube holes grooved by a Salter grooving tool. In this instance four grooves are being cut at once, but up to eight grooves may be required and the Salter tool will handle that number. Previously the grooves were cut in pairs

the pin centres. Such grooves could make good oilways for a rotating shaft and the projections a simple means of holding rubber mouldings or as an anchorage for white metal as a bearing surface.

The idea is limited as the amount the tool is projecting from the holder will restrict the movement to some extent, but as a few thousandths of an inch is generally sufficient for this type of groove, it will overcome the necessity of making another tooling set-up and eliminate a further operation in the layout.

Despite the long leverage from the tool to the pin centre which generally can prevent jamming, the lapping of the pin is regarded as essential because if the bore is locally hardened together with the hole in the swinging bar, a considerable period will elapse before visible wear takes place and the fitting of these details in this manner ensures that there is less likelihood of chatter occurring to mar the finish of the hole. Admittedly the bar slides in the slot, but even a thousandth of an inch clearance here can create chatter and the long length makes it almost impossible to specify anything less if a sliding fit is desired.

Only one angle is possible with the attachment in the present form, but by providing a wedge inside the slot—one surface corresponding with the 3° shown while the other has the desired angle, then alternative angles can be bored without much difficulty. This long strip requires holding with several screws and as these need tapped holes the latter would cause the tool to mark the bore of the component if no attempt were made to cover them during the machining process. A false floor to the slot is thus necessary on such occasions and when the previously mentioned projections are envisaged, but as the present design did not involve these problems they are excluded from the drawings shown here.

For very long tapered holes the only governing feature is the length of stroke made by the turret slide, and by employing this arrangement a much deeper bore is possible than with the usual style of cutters adopted for this class of work.

Electric Power Conductors over a Wooded Valley

The 275kV overhead transmission line between Carrington, Penwortham and Rochdale is being erected by British Insulated Callender's Construction Company Limited for the Central Electricity Generating Board. Between Blackburn and Preston the route of the line crosses a wooded valley near Feniscowles.

The company was asked to exercise special care to avoid damage to the trees during erection of the conductors between the supporting towers on each side of the valley—a span of 1,600 ft. In order to do this, a pilot line was fired across the valley by coastguard rocket apparatus. The pilot line was then used to take over a hauling rope by means of which the conductors were drawn across without damage to the trees.

Internal Burring Attachment

The drilling of a series of 1 in. dia holes through the walls of lengths of 9 in. dia by 10 ft long tube, did not initially appear a formidable operation. The actual drilling was, of course, a straightforward process, but unfortunately the large burr left behind inside the tube required removing and this presented a problem of some magnitude, especially when the drillings were situated in the centre of the 10 ft length.

After some attempts with files attached to long handles and a portable rotary burring head on a flexible shaft, it was obvious that to carry out the work economically a more rigid assembly was necessary, and care in piloting either a burr of countersink over the hole also needed attention to prevent the tool marking the bore. While it was not expected that the operation of completely de-burring the inside of the tube through which some twenty holes had been drilled would take but two or three minutes, it was hoped to reduce the time taken of about two hours to something like a quarter of that time; thus in an endeavour to achieve this economy it was realized that lightness coupled, with rigidity were the important factors.

A long piece of bright mild steel

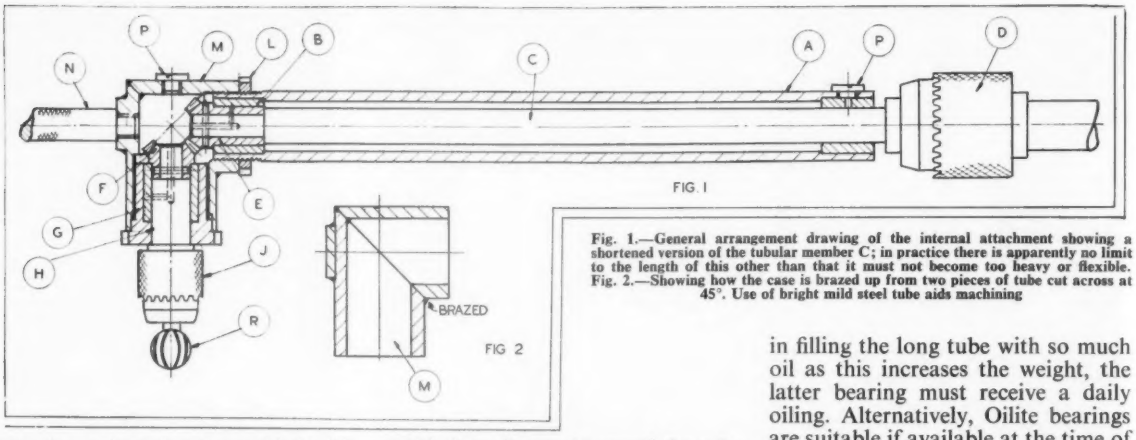


Fig. 1.—General arrangement drawing of the internal attachment showing a shortened version of the tubular member C; in practice there is apparently no limit to the length of this other than that it must not become too heavy or flexible. Fig. 2.—Showing how the case is brazed up from two pieces of tube cut across at 45°. Use of bright mild steel tube aids machining

tube A was bored and provided with two phosphor bronze bearings B, and through these members passed the driving shaft C, one end of which was reduced to fit the mitre gear E and the other to suit the drill chuck. As this driving shaft is of considerable length, a weight saving feature here is the use of tube instead of a solid rod—there is no great load so aluminium tubing will again reduce weight, and though a steel rod was employed in this example it is felt the introduction of a tubular driving member is preferable. The portions forming the bearings would then be steel inserts pinned in position and then turned between centres to ensure perfect concentricity.

Meshing with the mitre gear is another wheel F having identical teeth, thus the speed is the same for the burr as for the chuck, and a similar arrangement for holding it to the shaft and the same type of bearing is used. The latter is, on this occasion, inserted into a separate piece G, and to ensure that the gears run smoothly a turned spigot on this insert matches with a recess bored in the case M. The shaft fitted to the lower mitre wheel F and the smaller chuck for holding the burr, completes the assembly, but there are two or three points of interest worth mentioning especially the construction of this case M.

This is initially built-up by brazing from thick walled tube, the same type of assembly is possible if bar material is rough drilled prior to brazing if tube of a suitable thickness is not available, and Fig. 2 illustrates how, by adopting this idea, a casting is avoided and the result is perhaps a better looking and more robust job. The two pieces of material are angled to 45° and with the addition of a slice off a piece of 1 in. dia bar filed to enable it to fit snugly round the tube the brazed assembly takes but an hour or so to construct. The latter boss incidentally is merely to thicken the wall and so provide a longer depth of thread for the handle N.

Some care is necessary to ensure that the threads and recess are at right angles to each other, and if bright tube is used for this casing V-blocks make it easy to obtain the correct location while boring the holes. If too great an error results during this operation, the gears will not run smoothly, but they should not rotate tightly otherwise overheating and scored teeth will occur.

The case is filled with oil through the plug hole at the top, and a top-up before using if the tool has stood some days, is advised: with equipment of this type where no oil seals are installed, some leakage takes place usually round the shaft H as there is only a short distance for the lubricant to travel from the bearing. Oilways and grooves adequately lubricate these bearings, but as the right-hand member is so remote from the case and there is no point in filling the long tube with so much oil as this increases the weight, the latter bearing must receive a daily oiling. Alternatively, Oilite bearings are suitable if available at the time of construction.

There is apparently no restriction on the length of this attachment provided it is not too heavy to pick up without effort, and it is merely pushed down the tube until the second operator can grasp the handle N. A light electric motor incorporated on the end to drive the shaft instead of the chuck and flexible drive is a matter of choice. Usually accessories of this kind are best made self-contained and the mere plugging into a wall socket is easier than carrying round the drive, but even the smallest of these motors will add considerably to the weight. Again, a refinement of this nature also demands improvements in the bearings—ball races in lieu of those shown here is an obvious choice for free running, but then the attachment climbs out of the category of shop-made equipment constructed from scrap material. The equipment proved efficient in service, making burr removal a fairly speedy process and giving a superior finish to other methods tried beforehand.

Using the Chuck as a Tailstock Support

Generally, long articles are mounted between centres prior to being machined in the lathe or perhaps ground on the rotary type of grinder, and in this category are included shafts, pipes, forgings and castings and the application of the usual tailstock centre provides adequate support for all but the very heaviest machining.

Occasionally a shaft with a damaged centre or one lacking this necessity is encountered and this can create complications when it becomes essential again to mount the article in the lathe or grinder for a modification or some re-machining operation before assembling it.

On these occasions the three or four jaw chucks mounted on the tailstock often overcomes an awkward problem and enables the gripping of such a shaft to be performed without considerable and time wasting attempts attaching steadies to the machine bed and adjusting these to make the job rotate truly.

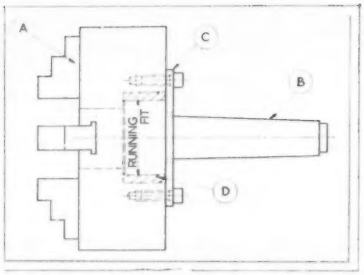
The sketch illustrates how the chuck A is secured to a taper fitting for the tailstock. The latter B is a substantial piece of steel turned to fit a phosphor bronze bush D

assembled in the chuck, and this part is attached to the chuck by a plate C, the screws of which assemble into the tapped holes already drilled in the chuck body or a series of holes drilled and tapped for that purpose. The thickness of the 'head' of this fitting B is faced off to make a good running fit—a thousandth or so clearance is perhaps not detrimental to the assembly as all the pressure is taken by the plate and this allows a free running chuck.

When the work is merely plain shafting which obviously does not possess rough surfaces and is circular and therefore does not need four jaws for clamping, the three jaw chuck is preferable because as it tightens on the shaft it promotes a concentrically rotating setting, but long forgings are typical components which a four jaw chuck will handle provided the tailstock fitting is made sufficiently substantial to support the heavy load.

An alternative design which is often possible, provided the chuck is large enough to accommodate the larger tailstock, is one incorporating a ball or roller bearing instead of the plain bearing, and this is preferable when heavy loads are being carried for long periods.

The exclusion of dirt is important with all attachments of this type and fortunately the position of the bearing, if the hole is plugged, makes it difficult for swarf to enter. An alternative is to add a thin steel plate at the bottom of the bush recess and completely blank off the hole and so exclude dirt in this way. Most



Equipment with a plain phosphor bronze bearing, but a ball or roller bearing is preferable when heavy cutting is encountered

machining operations are carried out remotely from the tailstock, thus there is little danger that chippings will enter as the chuck rotates. Refinements in the way of oil grooves with means of injecting oil into the bearing need little elaboration—a nipple screwed into the plate and centred to clear the tailstock barrel is suitable for occasional applications by an oil gun, and a heavy oil is retained in the bearing.

An attachment of this nature is best left as a unit and the chuck not detached from the tapered fitting because many instances arise in the workshop where some support is necessary during setting up and this equipment is much quicker to install than the fixed steady attached to the machine bed.

Bridge Type Indexing Jig for Drilling Strainers

The indexing jig shown in the accompanying sketches was designed largely to dispense with marking off and to ensure high production in the drilling of large diameter steel strainers, 30 in. dia and 22 ft long. The drilled holes were 1 in. dia and there were approximately 2000 holes per strainer. Fig. 1 is an end elevation of a strainer A, the indexing drilling jig consisting of two rigid brackets B bolted to the drilling machine table, and a cross member C carrying the indexing plunger D operated by hand-lever E. Supporting the strainer are two compound roller cradles F and F_1, seen more clearly in Fig. 2.

Cradles F and F_1 are mounted on and travel along T-bar rails G to give longitudinal movement to the strainers by means of flanged rollers H. Circular movement of the strainers is through rollers I, Figs. 1 and 2. The "marking off" consisted of merely setting out the first circular row of holes seen at Fig. 2. There were no tight tolerances on the job but accurate marking off of the first, or master, circular row of holes was arranged for and carefully checked. The same accuracy was accorded the drilling of the first row. To ensure this, a saddle-type jig. Fig. 3, J, conforming to the outside diameter of the strainer A, and of adequate wall thickness, carried a hardened and ground steel bush having a working fit bore for the drill.

When drilling the master row, the guide bush in jig J was accurately set to each marked off hole, in turn, and held in position by heavy clamps during drilling. A re-setting of the jig J, Fig. 3, was, of course,

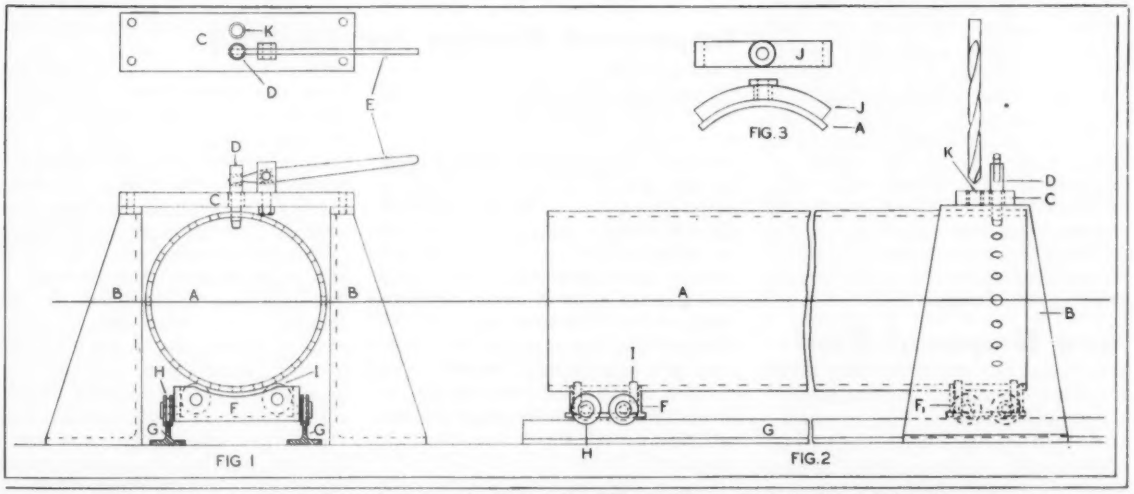


Fig. 1.—End elevation of strainer A and bracket B carrying cross member C of indexing drilling jig. Fig. 2.—Front elevation of steel strainer A mounted on compound roller cradles F and F_1 and moving on T-bar rails G. Fig. 3.—Front elevation and plan view of saddle type drilling jig J mounted on strainer A

necessary for each hole till the first, or master row was completed. From that master row, succeeding rows were drilled; two men, driller and helper, being employed. Cross member C, Figs. 1 and 2, carried, in addition to the indexing plunger D, a hardened and ground bush K, accurately spaced from the indexing plunger D to give the correct longitudinal pitch of hole, clearly seen at Fig. 2 with the drill in position.

In operation, the helper, stationed at the rear of the strainer, pushed it along while the driller, with a podger or bar in one hole of the master row, moved it around till their combined effort brought a hole in the master row in line with the indexing plunger D. The driller then raised lever E, Fig. 1, by hand and pushed the plunger into each master hole in turn. It will be seen from Figs. 1 and 2 that plunger D has a tapered and rounded nose to make easy engagement with the drilled holes. The hand manipulation of the strainer, longitudinal and circular, did not call for highly accurate setting.

With the strainers mounted on rotary and longitudinal rollers, setting "to a nearness" was good enough to admit the entry of the tapered and rounded nose of the plunger into the drilled hole. Continued upward pull by the driller on lever E did the rest. After the first circular row had been drilled with the indexing plunger engaging with the holes in the master row, the strainer was moved along another longitudinal pitch, the plunger then indexing in the second circular row, and so on to completion. The method proved to be remarkably fast and successful from a handling angle, becoming almost automatic before the first strainer had been completed. A high degree of accuracy for the class of work concerned was obtained along with a gratifying volume of production. The T-bar rails were stiffened by transverse bolts at regular intervals, each bolt having an inner and outer nut at either end. This arrangement also kept the rails parallel.—**C. Donald.**

Key Removal Tool

Numerous devices have been made for the extraction of headed keys of the type depicted at Fig. 1, usually incorporating some threaded arrangement where the turning action of a screw causes the pressure to pull the key from the seating.

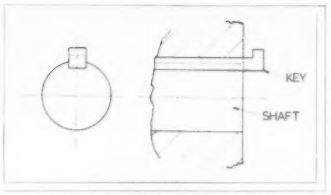


Fig. 1.—Typical headed key

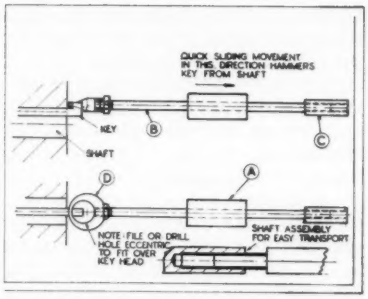


Fig. 2 (right).—Assembly of impact type key remover. A, sliding weight; B, rod; C, end stop; D, hardened ring

While this method is satisfactory and there is little difficulty in pulling the tight and often rusted key away, the maintenance fitter on the road to service his firm's machines in the works of their customers, cannot hope to carry around with him several extractors of different dimensions, and he must of necessity restrict the number of tools.

A useful key remover which can accommodate various sizes, provided there is not too great a variation in the heads, is illustrated at Fig. 2, and though it may not have the same extracting force it does overcome the above-mentioned problem. Another advantage is the facilities offered for dismantling the extractor for carrying, or for adding an additional length for use when a particularly stubborn key is encountered.

The principle is nothing more than a sliding weight hammering the end of a long rod—the blow jerking the key from the seating, and as a considerable force is applied, two or three blows are sufficient.

If the long bar is made in separate parts, drilling and tapping one end and threading the other to make an easy fit is the simplest method of joining and overcomes the need for a long bar and makes carrying easier; also the fact that the hole in the weight is not a neat fit means that the weight can slide over the joint without hindrance. A brief application of a fine file where the two sections of bar join together removes any step caused through the threaded diameters not locating accurately, and there is no need for the usual spigot and recess diameters to locate the two parts.

The end which fits round the head of the key is a slice of steel bar drilled and filed with a flat to suit the keys. Offering the piece to one or two assemblies is perhaps the best way of ascertaining the best size to make this part, and a tapped hole in the end with a fairly coarse thread holds it securely to the bar. Lead is the traditional material for weights, but on this occasion a piece of bright mild steel parted from the bar with the edges removed to make it nicer to handle is preferable. A light cyanide or case-hardening on the ring will overcome any damage caused through repeated hammering.

Improved Design for Casting

Castings form a large proportion of the raw material of the engineer and often slight modification to design can enable the foundryman to produce the required casting with far less risk of failure. A number of cases recently came to the notice of the writer where castings were behind on delivery and on enquiry it was found that difficulty was being experienced, due in most cases to design. A conference between the designer and foundryman was then arranged and certain modifications decided which greatly facilitated the production of these castings without interfering with the function of the machine.

One of these modifications was the thickness of the metal section in one part of a casting where trouble was being experienced from "cold shuts" because of the metal chilling in its passage through the mould as it was bottom poured. A slight increase in thickness of the plate of metal causing the trouble enabled these castings to be produced quite easily.

Another case concerned the coring of a water jacketed cylinder head. In the casting as designed it was necessary to core out a small passage which caused great trouble to the foundryman, as the core forming this had to be made integral with another of much greater bulk. The trouble experienced was that if the core was baked so as to enable the gases to escape freely from the large portion the passage part was

unduly burnt and was thus easily eroded by the metal flowing through the mould. On the other hand, if this was not baked quite so much, trouble arose from "blowing" of the other part of the core because of the excessive evolution of gas which had not been driven out during the baking period. When told of this difficulty the designer considered that the doubtful advantage which the passage conferred on the cooling of the machine was not sufficient justification for incurring such a high waster risk, and consequently he eliminated this difficult part of the core, with subsequent expedition of good castings to the machine shop.

Many engineers have the erroneous idea that the heavier and bulkier a casting the stronger it will be. Often the converse is true, as large lumps of metal are invariably a source of weakness, unless extraordinary foundry precautions are taken to ensure the feeding of their heavy sections with live metal to counteract excessive shrinkage. This entails either the expedient of rod feeding, which, unless done very thoroughly, is liable still to leave contraction cavities, or the placing of large self-feeders over the heavy sections. Whilst the latter is the better method it entails the melting of considerably more metal and the subsequent removal of the sizers. But why produce a design which needs these costly methods of manufacture? A re-design of the piece with foundry requirements in mind will often result in a stronger and cheaper component.

Fig. 1 shows a casting which, as originally designed, was expensive in many ways, for not only was it a foundry problem to ensure solidity in the junction A, but the machine shop spent considerable time "cutting wind" when machining the face B. It is a good rule in casting design to endeavour to get all sections as nearly uniform as possible so as to avoid "hot spots" and the resulting contraction cavities. When this is not practicable, the change in section should be as gradual as possible and the method of testing doubtful sections with inscribed circles is to be commended. This method takes the smallest section and, using this as standard, endeavours to get all other sections as near to it as practicable. Thus in Fig. 1 this circle C is smallest, but the area covered by A is very much greater, whereas in the re-designing bracket in Fig. 2 the variation between C and D is considerably less. The design is thus much easier to produce in sound castings and ribbed as shown it is far stronger. Not only is the resultant casting lighter, but less metal need be poured as no heavy risers are required in this equisectioned design. By cutting the hold-down ears back from the main face the machining time, too, is reduced considerably.—**T. R. Harris.**

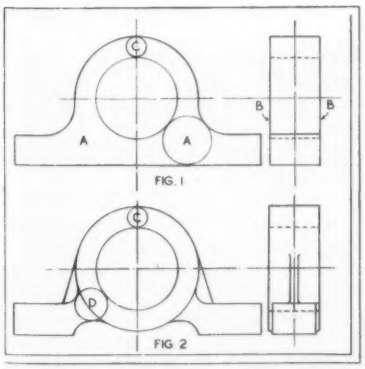


Fig. 1.—Poorly designed casting with considerable variations of section at A and C and no facings at B

Fig. 2.—Improved equisectioned design

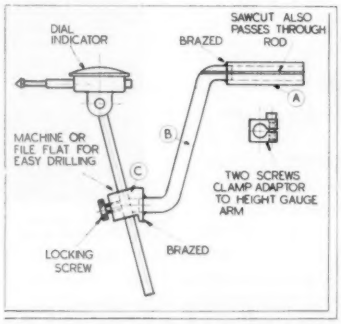


Fig. 1.—Details of indicator adaptor showing method of construction. The length of the spindle depends on the type of work

Dial Indicator Adaptors

All too often the machinist is observed using the dial indicator in odd corners and making great efforts to ensure that the bar on which the indicator is secured does not contact some portion of a component and and so render the reading inaccurate. Such endeavours take rather a long time and on many occasions the results are not successful despite the care and the time spent on them.

The construction of the adaptors seen in the drawing solves many of these difficulties and because of the shape and the angularity of the hole for the dial indicator spindle, enables the pointer to reach corners normally found impossible with the orthodox style of fitting.

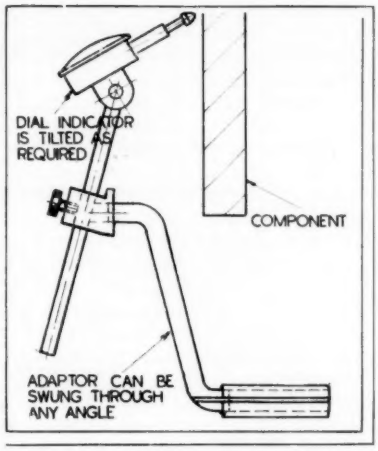


Fig. 2.—A typical setting for the adaptor. The fact that the spindle can rotate 360° greatly increases the scope of the device

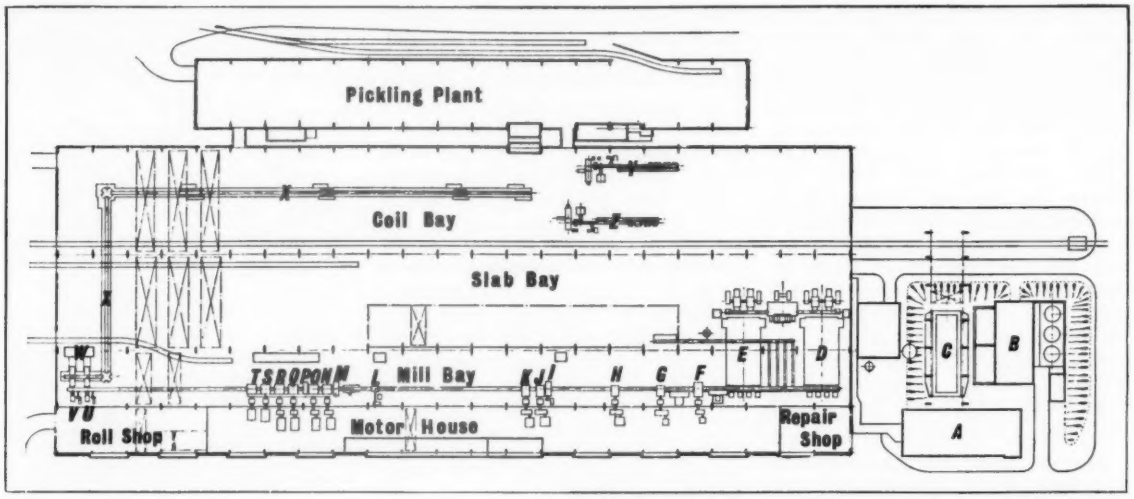
How the adaptor is secured to the height gauge will obviously depend on its design but the arrangement A is simple, utilizing the split bush type of fitting and two small socket head screws are adequate for holding.

The cranked spindle B is merely a length of bright mild steel bent to an angle of approximately 75°. This angle is only a suggestion because if a longer reach is desired then 45° considerably increases the distance of the indicator from the height gauge.

Another short length of steel C is brazed to the cranked part and the angle filed to make a square seating for the drill when the tapped hole for the screw is machined, and the hole accommodating the indicator spindle is drilled and reamed. Again the angle is filed for that purpose.

The bar is now brazed to the holder—the latter is not split until after this process because the cutter milling the gap can run into the bar and so create some springiness at that end. Incidentally, the bar is set in relation to the holder prior to brazing in order to preserve a good appearance.

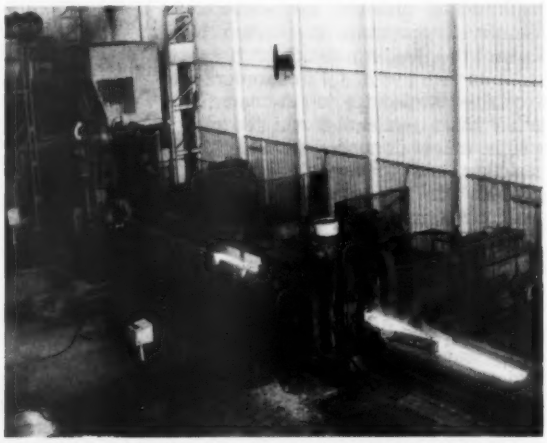
Whether case hardening is required is a matter of opinion. Continued usage will undoubtedly demand this form of protection, but for occasional use ordinary care will ensure preservation.



Layout of the Brinsworth medium width hot strip mill. A, office building. B, pump house. C, scale pit. D, E, furnaces. F, horizontal edger. G, H, J, K, two-high roughing stands. I, M, P, vertical edgers. L, flying shear. N, O, Q, R, S, T, four-high finishing stands. U,V, hot strip coilers. W, control pulpit. X, conveyors. Y, Z, shearing lines

Continuous Hot Rolling of Medium Width Strip

The new Brinsworth 18 in. mill at Steel, Peech & Tozer



Slab passing through No. 1 roughing mill stand. At left is the horizontal edging and scale-breaking stand. The delivery roller table is fitted with a manipulator to turn the slab flat and shift it into any desired pass centre

IN the face of the present recession in the steel industry the future of the new Brinsworth medium width strip mill at Steel, Peech & Tozer can only be considered on the merits of its long term prospects. Over the post war years there has been a demand for steel plates, sheets and strip, largely as a result of increased manufacturing of consumer goods. It was with this market in view that The United Steel Companies Limited, Sheffield, decided in 1955 to erect a highly-mechanized continuous hot strip mill capable of rolling mild, carbon and special steels up to 18 in. wide, thus bridging the gap between the outputs of the narrow and wide strip mills now operating in this country. The mill which was commissioned in the Autumn of 1957 will have an ultimate capacity of the order of 8000 ton per week and provides a wide range of strip gauges. The minimum strip gauges are as follows: 16 to 18 in. wide down to 0·060 in. thick, 12 to 16 in. wide down to 0·056 in. thick, 7 to 12 in. wide down to 0·048 in. thick and 4 to 7 in. wide down to 0·042 in. thick. The maximum strip thickness is 0·25 in. for all widths. The main markets for the strip are material for cold rolling, tube making and the motor car industry, the latter probably offering the largest single outlet.

Major excavations on the site began in early August, 1955, and entailed the removal of some 350,000 cubic yd of soil, shale and soft rock, the foundations for the mill building and substructure being taken down about 12 ft to rock level below the original surface. By the beginning of 1956, foundation work for the main mill building was well advanced and erection of the 3400 ton of structural steelwork began. The structure includes substantial quantities of castellated open web beams.

The building has an overall length of 800 ft and is approximately 300 ft wide and with its frontage of rustic brickwork alternating with deep panels of glazing, it presents a thoroughly modern appearance. The back and sides of the building are almost entirely sheeted with protected metal, the roof being formed of Q decking and incorporating adequate ventilators. The mill is divided longitudinally into four bays; the motor room, an extension of which forms the roll preparation bay; the main mill bay, followed by the slab storage and conditioning bay and the coil storage and despatch bay.

Motor room and roll shop

The main electrical equipment for the mill, supplied almost entirely by The English Electric Company Limited, Stafford, is accommodated in a separate pressurized motor room, the bay also containing a roll grinding shop and a maintenance shop. An interesting feature of the mill is that it is rectifier fed, the electrical feed to the main drive d.c. motors being converted from a.c. by a bank of mercury arc rectifiers. The number of rotating machines is, therefore, reduced and such heavy foundations are not required, thus reducing the initial costs and maintenance. Cooling air for the main motors and rectifier cubicles is provided from a central ventilation system in the basement, while there is an external fan house, incorporating viscous type air filters of 200,000 cfm rated capacity. Power plant for the mill's water requirements has an installed capacity of 3000 hp.

The roll grinding shop contains two 26 in. Craven roll grinding machines, both of the traversing grinding head and stationary work-table type. One machine is designed for grinding dismantled rolls, while the other can accommodate rolls in their bearing chocks. The 7-ton overhead crane in this shop is arranged for floor control to facilitate the positioning of rolls on the machines.

Slab bay

At the north end of this 96 ft wide bay, two rail tracks enter the building for the transport of slabs from the Templeborough works. Here, the slabs are unloaded and examined, any surface defects being burnt out. A semi-portal crane is provided for handling the slabs, which have a maximum length of 28 ft 6 in., 3 in. thickness and 18 in. width.

In addition to the 5-ton semi-portal crane, the bay is served by three 15-ton overhead cranes, equipped with lifting beams.

Main mill bay

This bay contains the heart of the installation—the continuous rolling mill and its associated reheating furnaces.

From the slab bay, slabs are placed on the grid of a depiler, which incorporates a 30-ton weighing machine. The depiler situated centrally between the two reheating furnaces, is fitted with a pusher and electrically-operated lifting table. A chain conveyor removes single slabs to either of the two furnace charging roller tables.

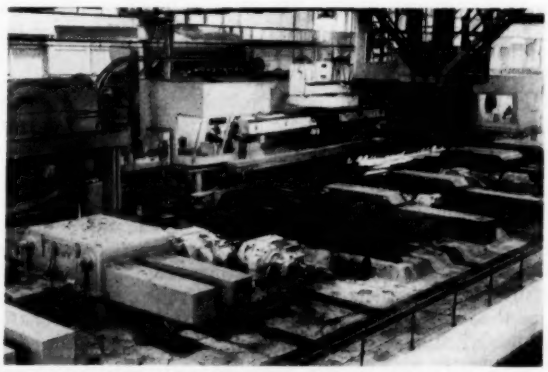
The 60 ft long, oil-fired, reheating furnaces are each capable of heating 75 ton of slabs per hour up to 29 ft long, up to 3 in. thick and varying from 5 to 20 in. in width. Both are equipped with Schack recuperators, in which the air for combustion is preheated, waste gas flues and cold air ducts enabling the recuperators to be by-passed for repairs. There is a 22,000 cfm cold air fan and a 70,000 cfm waste gas fan for each furnace. The furnaces are of the end charging and discharging type, the slabs being pushed through the heating zones by means of electrically-operated twin pushers. There are two heating zones—known as tonnage and soaking, respectively—the second zone being divided into three control zones across the width of the furnace. Rust back-atomizing burners fired with heavy fuel oil, are used on both zones together with a specially designed air-throat which ensures good distribution of air around the oil atomizer, and also equal distribution of air from burner to burner. The burners are steam atomized at pressures of the order of 60 to 70 psi. Nine burners are provided in the heating zone and twelve in the soaking zone. A comprehensive system of instrumentation and fully automatic control covers temperature, atmosphere and pressure in the various heating zones and variations are recorded on a multichannel recorder.

If a slab has to be diverted from the mill on emerging from the furnaces to a discharge table, it is conveyed to a section of the table between the two furnaces. Here, the slab can be positioned and then conveyed by means of a slab transfer to a roller table and so back into the slab bay.

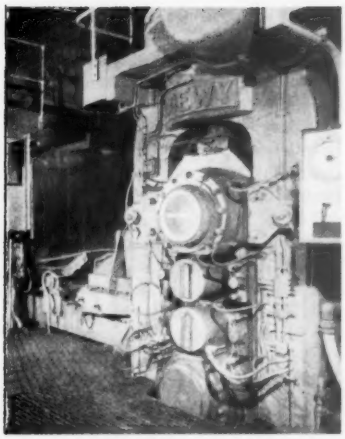
A 135 ft long live roller table, extending across this discharge end of the two furnaces, takes slabs to the first section of the mill, consisting of a horizontal edging and scale-breaking stand, driven by a 350 hp a.c. motor through a flywheel-assisted reduction gear. The horizontal edger is equipped with manipulators on the ingoing side to turn the slabs on edge, while further manipulators on the outgoing side turn the slabs back ready for entry into the first roughing stand.

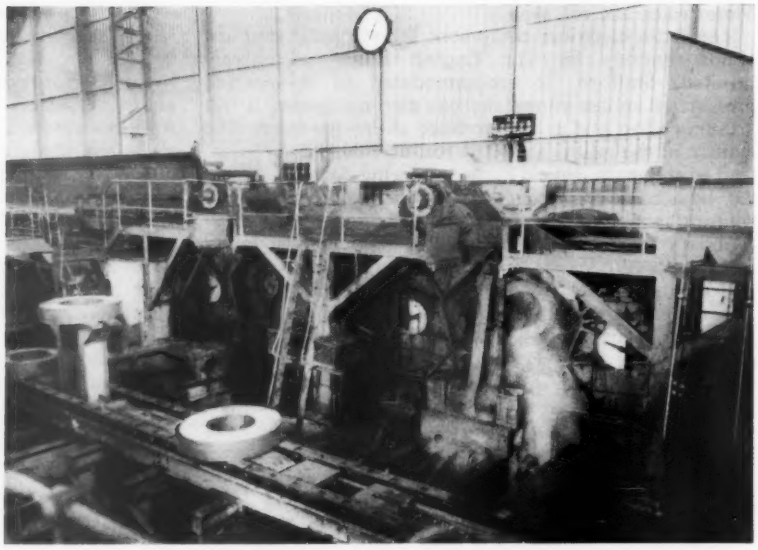
The roughing train comprises four two-high mills having 21 in. dia rolls of 24 in. barrel length. Preceding No. 3 rougher, there is a 26 in. vertical edging stand, whilst between stands Nos. 1 and 2 there is a free run of 38 ft with a 63 ft run between stands Nos. 2 and 3. Stands Nos. 3 and 4 are close-coupled. A centralized oil lubrication system supplies the main gearbox and pinion stands of the roughing train, a visible and audible alarm system operating automatically if the oil pressure falls below a predetermined limit. All the stands in this train are equipped with totally-enclosed, water lubricated fabric bearings. No. 1 stand of the roughing mill is driven by a 700 hp a.c. motor through a flywheel-assisted reduction gear unit, Nos. 2 and 3 stands by 1200 hp a.c.

Motor room, showing four of the six drives for the finishing mill



Two reheated furnaces, showing slab depiler and furnace pushers. Each furnace is capable of heating 75 ton of slabs per hour





The four-high mill stands are fitted with power-operated roll changing rig and sliding guide tables. Torque motor operated loop lifters are situated between the stands

Right, the strip is coiled on either of two 20 in. dia horizontal down coilers, each having a collapsing mandrel and nine driven guide rollers

salient-pole synchronous motors, and No. 4 stand by a 1200 hp d.c. motor.

From the roughing mill, the stock travels along a 150 ft long delay table before passing a rotary flying shear, which can be used for either end trimming, or emergency shearing in the event of "cobbles" in the finishing train. Powered by a 300 hp d.c. motor, the shear can cut hot strip up to 1 in. thick and 18 in. wide travelling at a speed of up to 450 fpm.

The stock, having passed through the roughing train, is held by the shear operator on the delay tables until it has cooled to the correct rolling temperature and is then allowed to enter the finishing mill.

The finishing train of the strip mill has six four-high rolling mill stands and two vertical edgers. Both edgers are driven by 75 hp motors, the first being situated in front of No. 1 finishing stand, and the second between Nos. 2 and 3 finishing stands. To ensure that speed differences between the edgers and the main drives neither damage the strip nor overload the edger drives, the control is arranged for the edger motors to have a 20% regulation characteristic throughout the speed range. Each of the six finishing stands has 14 in. dia work rolls and 23 in. dia back-up rolls, all being of 23 in. barrel length. The mill stands are equipped with electric screwdown gear, the work rolls being mounted on tapered roller bearings, and the back-up rolls on multi-roller cylindrical type bearings. Lubrication of the bearings is carried out by means of an automatic pumping system. A centralized oil lubrication system, similar to that installed on the roughing mill, supplies the main gearbox and pinion stands. Stand No. 1 is driven by a 1200 hp d.c. motor, Nos. 2, 3, 4 and 5 by 1750 hp d.c. motors and No. 6 by a 1200 hp d.c. motor.

Master and supervisory control of the main drives for both roughing and finishing mill is carried out from open-type boards with all the components mounted on polished slate panels. Associated with the control boards are the 400 cycle magnetic amplifiers. These are chassis mounted units fitted into cubicles with full monitoring of reference and output windings. All control of main drives and a large percentage of auxiliaries is carried out from pulpits designed for seated operators overlooking the mill.

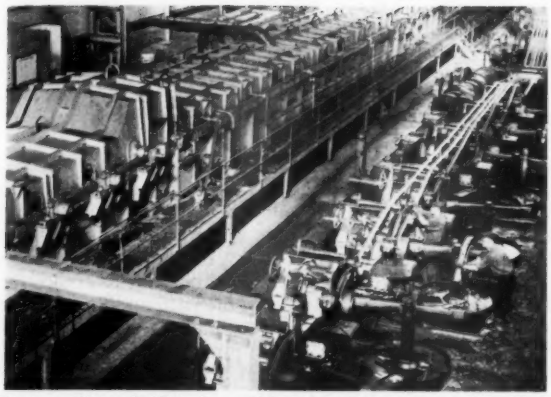
Auxiliaries

By the time the strip reaches the last finishing stand, it is travelling at up to 3000 fpm and proceeds along a 160 ft cooling table where a bank of water sprays can be used if cooling is required, Next, the strip is coiled on either of two 20 in. dia horizontal down-coilers, each operated by 175 hp d.c. motors. The two down-coilers each with collapsing mandrels and driven guide rollers are of patented design to ensure tight and even coiling at speeds up to 3200 fpm without deformation of the strip due to hammering. Coiling is carried out at 750–850° C and the mandrels are changed every three weeks for overhaul and maintenance. Coils ejected from the coiler mandrels are lowered on to an extensive slat chain conveyor system leading to the coil storage bay.

During the actual rolling process, continuous measurements of the temperature, width and thickness of the strip are taken. The temperature is measured at four points and recorded on large circular indicators which are clearly visible to the mill operatives. Strip width is measured between the last finishing stand and the coilers by means of a photo-electric telescope system mounted above the cooling table, deviation of the actual width from the desired width being indicated in a similar manner to the temperature readings. Thickness measurement is also obtained by non-contact means, employing a radio-active source positioned beneath the strip and a detector unit above the strip. The intensity of radiation reaching the detector varies with strip thickness, the variations—after passing through electronic equipment —being displayed pictorially on a large lamp display board on the motor room wall. A more permanent record is transmitted to a teleprinter in the finishing mill pulpit.

Coil Bay

The 600 ft long coil conveyor runs underneath the slab bay and emerges down the middle of the coil bay, from where the coils can be lifted by magnet crane and placed in storage while cooling. The conveyor operates at a speed of 30 fpm and can handle coils weighing up to 5600 lb. It incorporates a 3-ton weighing machine, fitted



The two multi-strand pickling lines, which are housed in a separate building alongside the mill building

with chart and card punch recording equipment.

There are two shearing lines, each comprising a decoiler, an edge trimming shear, a roller flattener combined with a flying shear, a piling device and a 10 ton weighing machine. They are capable of shearing strip up to 18 in. wide × 0·08 to 0·25 in. thick in maximum lengths of 30 ft. A separate inspection line is installed at the north end of the bay, where strip up to 19 in. wide and from 0·042 in. to 0·25 in. thick can be gauged and inspected. The line includes a hydraulic shear for removing faulty material and can produce small coils of strip, if required.

A railway dock extends the full length of the bay, adjacent to the slab bay, and road transport can obtain access at both ends of the bay for the despatch of finished products. Three 10-ton overhead cranes serve the coil bay.

Pickling Plant

As a proportion of the hot rolled strip is pickled before despatch, a separate building, 550 ft long × 66 ft wide, has been built alongside the main building to accommodate two multi-strand pickling lines with appropriate ancillary equipment. Here the scale is removed by a combination of mechanical and chemical means. The strip is uncoiled and fed between staggered steel rolls which bend it sufficiently to break up the hard, loosely adhering scale. The strip then passes through a tank of dilute sulphuric acid to remove the remainder of the scale, the acid being removed in hot and cold water tanks. Finally, the strip receives a coating of soluble oil before recoiling. Acid recovery and neutralization plants are located on an adjacent site away from the pickling plant itself.

Mill Services

Water requirements for descaling, roll cooling, strip pickling, etc., amount to approximately 600,000 gph. Part of this water is filtered and recirculated, and the remainder, such as that used for roll cooling, is given ample settling time in a large scale pit before being recirculated. There are five distinct pumping systems for furnace cooling, roll cooling, delay table and fabric bearings, scale flushing, and runout table and coilers, respectively.

High pressure descaling water is taken from the make-up supply after filtration. Make-up water, amounting to 5% or 30,000 gph, is taken from the rising main supplying the main works filtration plant at Brinsworth.

Service pipes carrying steam, oil, coke oven gas, water and compressed air from the company's Templeborough works across the Sheffield Road are contained in a quarter-mile long service tunnel, 8 ft 6 in. in dia. The pipework includes 7 in. bore steam mains, 4 in. bore oil mains, 2 in. bore gas piping and 4 in. bore water mains. A compressed air main runs between the Brinsworth mill compressor house and the Templeborough melting shop. Inside the mill building, the reheating furnaces are supplied from 2½ in. bore steam and oil mains, while 4 in. to ¾ in. bore gas, compressed air and water mains serve the strip mill. A 6 in. bore process steam main runs to the pickling tanks, heat exchanger, regenerated acid tanks and shop space heating system.

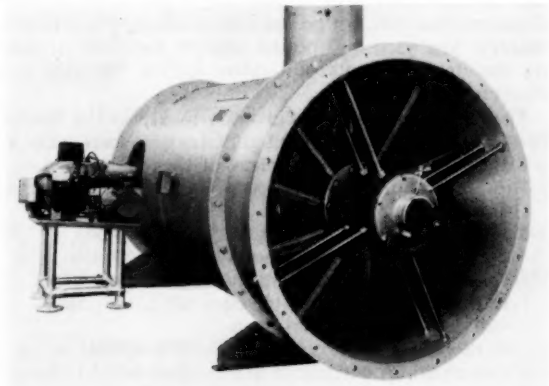
The intercommunication system at Brinsworth, a vital factor in the efficient operation of a modern, high speed rolling mill, comprises microphones and loudspeakers at strategic points throughout the building; the main mill system has 28 key points, any one of which is in direct and immediate contact with all the others.

Information required for the mill records is conveyed by means of teleprinters, which enable each slab to be individually identified and followed through from the slab bay to the coil weighing machine.

Finally, there is a pneumatic tube system in operation. Internally, this is utilized for passing messages between the slab bay and the re-heating furnaces and between the furnaces and the coil weighing machine. Externally, there is a pneumatic tube link with Templeborough works.

To provide a centralised registration of the production performance of the machines a Centralograph recording instrument has been installed. During normal production detecting contacts on the machines transmit electrical impulses to the Centralograph, which are recorded as short horizontal lines on a time-referenced diagram called a centralogram. Divided into 20 columns to represent the machines, the diagram shows at a glance the machine working and idle times.

In the Brinsworth mill, Centralograph control points are situated at desired positions from the furnaces through to the coil bay shearing lines, and by analysing the centralogram, suitable adjustments can be made to the planning of the work flow.



OIL-FIRED HEAT EXCHANGER.—An economical simple method of supplying hot air through ducting for space heating or drying purposes this unit has been designed for use with Woods of Colchester Limited aerofoil fans and any air volume/pressure combination can be obtained by using single-stage or multi-stage fans of various sizes. Within the cylindrical casing is a radial finned bank combined with a combustion chamber into which fires a Nu-way jet oil burner. Air is passed through the casing, over the radial fins, and absorbs about 80% of the heat generated by the burner. There is no contact between the air flow and the products of combustion

Metric Conversions

International yard and pound

THE various standards of length and weight throughout the world have nominal relationships which are accurate enough for most purposes. Now, however, developments in precision engineering have overtaken the discrepancies and present circumstances have led to the following statement being issued by the six laboratories mentioned:

"The Directors of the following standards laboratories have discussed the existing differences between the values assigned to the yard and to the pound in different countries.

Applied Physics Division, National Research Council, Ottawa, Canada.
Dominion Physical Laboratory, Lower Hutt, New Zealand.
National Bureau of Standards, Washington, United States.
National Physical Laboratory, Teddington, United Kingdom.
National Physical Research Laboratory, Pretoria, South Africa.
National Standards Laboratory, Sydney, Australia.

To secure identical values for each of these units in precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definitions:

the international yard equals 0·9144 metre;
the international pound equals 0·45359237 kilogramme.

"It has also been agreed that, unless otherwise required, all non-metric calibrations carried out by the above laboratories for science and technology on and after July 1st, 1959, will be made in terms of the international units as defined above or their multiples or submultiples."

The new international units conform with the recommendations of the Board of Trade Departmental Committee on Weights and Measures Legislation (the 'Hodgson Committee') but the Board of Trade point out that the units will have no statutory force in the United Kingdom and may not be used for trade purposes in this country. The yard and pound units to be used in trade are the imperial units laid down in the Weights and Measures Act, 1878.

The values of the yard currently in use in the British Commonwealth and the United States of America are as follows when expressed in terms of the metre:

1 imperial standard yard ...	= 0·9143972 metre
1 Canadian yard	= 0·9144 metre
1 yard as at present used by the National Physical Laboratory for science and technology, based on the 1922 value of the imperial standard yard	= 0·91439841 metre
1 United States yard	= 0·91440183 metre

As the imperial standard yard is about 5 parts per million (0·0002 inch) less than the United States yard (which is defined in terms of the metre) and is shortening at the rate of over one millionth of an inch per annum, the consequent discrepancies in measurements of length are important in modern precision engineering. To give two examples, it is necessary to know the lengths of the highest grade block gauges accurately to one part per million, and the permissible error on accurate yard scales is 0·0001 inch. Though the N.P.L., by using the metre and wavelengths of light and by adopting the 1922 value of the imperial standard yard in relation to the metre, has been able to stabilize its basis of reference for length measurements in terms of the yard and its common submultiples for science and technology, unification of the yard standard for these purposes in the British Commonwealth and the United States can no longer be delayed.

With regard to the pound, the values currently in use when expressed in terms of the kilogramme are:

1 imperial standard pound	= 0·453592338 kilogramme
1 Canadian pound ...	= 0·45359243 kilogramme
1 United States pound	= 0·4535924277 kilogramme

There is evidence that the imperial standard pound has diminished by about 7 parts in 10 millions since 1846. It is about 2 parts in 10 millions (0·0014 grain) smaller than the United States and Canadian pounds, which are defined in terms of the very closely safeguarded international prototype kilogramme. Though the discrepancy between the pounds is not at present causing any technical difficulty the coexistence of independently defined pounds is unsatisfactory in science and technology.

The agreed international values of the yard and the pound fall between the existing United States and British units, and the international yard, which is the same as the Canadian yard, accords exactly with the relationship 1 inch = 25·4 millimetres, which is already extensively used in this country and abroad for approximate conversions. The adoption of the international values of the yard and the pound will be of particular benefit to all those concerned with accurate measurements of length and mass for scientific and technological purposes in the British Commonwealth and the United States.

Eliminating Post-welding Stress Relieving of Magnesium Sheet

A new magnesium sheet and plate alloy that does not require stress relief after welding has been developed by The Dow Chemical Company. The alloy, ZE10A, which contains zinc and rare earth metal as alloying constituents, is in production at Dow's Madison Division, Madison, Illinois, and is available for overseas markets through the facilities of Dow Chemical International Limited S.A. Its main advantage is in the construction of large structures and in field repair operations where stress relief is difficult to apply. Other applications include storage and shipping containers for bulk products, and tank-trailer bodies.

Typical mechanical properties for ZE10A in the H24 temper (strain hardened, then partially annealed) include: tensile 38,000 psi; tensile yield, 28,000 psi; compressive yield, 26,000 psi. The alloy also is furnished in the fully annealed condition.

Plant Progress

TO THE EDITOR OF MECHANICAL WORLD

Sir,—I was interested in reading your Editorial "Plant Progress" in the issue of November last.

It is not always easy to justify new capital for modernization or mechanization. In respect of machine tools where the work potential to be produced is more positive the situation may be solved by making a comparatively simple calculation. For process work the problem is not so simple. For this particular work, as yet, there are no mechanical aids for checking and rejecting faulty work throughout the full programme. There are mechanisms for inspecting incorrectly filled or closed cartons, misplaced cartons or work, but there are no devices available to check if the article has been correctly covered, the wrapping torn or incorrectly sealed, etc., all of which have to rely on visual inspections.

The employment of new equipment may be a disadvantage if the equipment cannot be fully employed, for the greater the mechanization the greater the minimum market to enable the project to be an economic proposition.

Compared with hand methods, semi-automatic or slower moving equipment there is a loss of adjustability and flexibility, and to take full advantage of the increased potential, second cost materials like paper, foil, film, cartons, adhesives etc., must be of a higher quality than before and also they must be held to closer tolerances.

There may be an increased number of manual operations required to enable the machine to work at the enhanced rate of output. A point that is very often forgotten with increased outputs is the larger amount of floor space around the machine and the additional warehouse space to store the increased volume of finished work. To maintain the increased production the maintenance staff must be kept in proper relationship to keep the break-down time to the minimum.

On the credit side, there is the higher rate of output, reduced labour cost, reduction in labour turnover, less machine floor space, more consistent quality and production control per unit produced.

When making a proposition for the substitution of hand by machine methods, the margin is generally so large that many minor considerations can be ignored. When superseding existing machines with newer models the chances are not so great and in addition it is usual to charge the new scheme with the annual costs from the old machine and spread over the same number of years as is being allocated for the life of the new equipment.

In your Editorial you suggested that all relevant information must be collected at all times. The position today is that machines are almost identical in their method of execution and are only distinguishable by the guards and the colour of their paint. It is only perhaps on some minor point or personal fancy that the final choice will be made, especially if one's list is made up of output speed, delivery, operators required, floor space required, price, etc.

When preparing a case to justify the borrowing of new capital for the purchase of new machinery, one generally has full knowledge of available equipment for each particular operation, and eventually one prepares a list covering all the available data as listed on the descriptive leaflets and covering letters which have been supplied by the machine makers.

A large amount of additional information is also necessary before the list is complete, and what is not realized is the number of points that can easily be passed over and cause considerable trouble and expense later. With this in mind the following has been compiled.

CONSIDERATIONS FOR SITE

1. The width and height of doors and openings through which the machinery is to be taken.
2. The size of the available hoists and cranes and their maximum loading.
3. Are the passages wide enough to permit the machinery to pass freely?
4. Are the permissible floor loadings sufficient for the machine to be carried as a single unit?
5. Is the permissible floor loading on the whole of the final site of sufficient capacity to carry the complete equipment?
6. Has provision to be made for vibration caused by the machines?
7. Are there any existing stanchions, air ducts, hoists, electric, water, brine, gas, air lines, sprinkler units, drain pipes or any other like important or immovable equipment or structures in the way?
8. Is the floor construction such that it can take the accepted method of securing the machinery in its position?
9. What is the available electrical supply and is it capable of taking this additional load?
10. Will the ceiling heights permit hoppers at the correct height, servicing, etc?
11. Have the building modifications been accepted by the local council?
12. If air is required, is it to have separate air compressors or is it to be built in?
13. Have these units been passed by the proper authorities, certificates issued and insurance taken out?
14. Has the Factory Inspector any comments to make? Have the local safety laws and the factory's own safety regulations been met?
15. Can the installation be made when the rest of the machinery on the same floor is in operation?
16. Has a decision been made as to what services are to be provided by the machinery suppliers and the buyer?

CONSIDERATION FOR MACHINE'S ARRIVAL

17. Is there ample lifting tackle of the right capacity available?
18. Is there enough space available for storing and uncrating?
19. Is there enough auxiliary tackle such as jacks, hoists, trucks, timber, etc., available?
20. Will the additional labour be available at the right time should the installation people ask for them?

CONSIDERATION WHEN ON SITE

21. What additional work tables, stools, trays, etc., are necessary?
22. Is there enough area around the machines to permit the passage of trucks, platforms, personnel?
23. Will personnel be trapped behind tables or conveyors should there be a fire?
24. What methods are to be adopted to ensure ample quantities of second cost materials being available?

25. Is there space for a buffer stock of work should there be a breakdown in manufacturing?
26. Is there ample space to store finished work temporarily?
27. Can or are there any conveyors being provided and by whom?
28. Are these machines to be linked up with any of the existing equipment at the time of installation or will it be done at a later time?

CONSIDERATIONS FOR SERVICE MEN

29. Who pays the cost of installation?
30. Has accommodation been provided for the service men?
31. What limitations are to be placed on these men such as regarding overtime, workrooms and areas which are out of bounds, and whether they are to be accompanied by a member of the machine user's staff at all times?

CHECK POINTS AGAINST ORDER

32. Are the motors, switches, starters, etc., of the type preferred and for the correct voltage?
33. Are the areas for the operators of the correct size and width?
34. Are the machine controls at their correct position and height?
35. Is there enough room clear of the machine for the number of operators specified?
36. Has any operator a restricted view of that part of the machine which is feeding items into the whole?
37. Have all dangerous areas been guarded, and safeguards provided to avoid accident and damage to personnel and machines?
38. Is provision made for cleaning the machine?
39. Have the necessary parts which call for special metals, plating or treatment been made as specified?
40. Can all lubrication points be reached without taking off guards, etc.? Can automatic system be installed?
41. Is the colour and kind of paint correct for the schemes and capable of withstanding spillage and also cleaning operations?
42. Under what conditions will the machine be operating? Has there been any change since placing the order?

WHAT TO TELL THE INSTALLATION FITTER

43. The difficulties already experienced with the product and materials.
44. Any seasonal peculiarities about the above.
45. The likely variations in size or shape, consistency, viscosity, density, and variations that can be anticipated in the second cost materials such as static, slipping, blocking, creasing, tracking, etc.
46. The likely frequency of each size of product.
47. What facilities are provided for effecting mechanical modifications to the machines if any should be required?
48. Procedure for obtaining actual samples and materials that will eventually be used with the installation.
49. The number of operators that will eventually be used on the machine and their function.
50. Time that will be required to complete other work such as trunking, services of all kinds as the work proceeds.
51. The desired completion date of all installation work.
52. How long the training period will be for the various machine operators?
53. The arrangements of siting and instructing the user's staff for effecting any size changeover.
54. The time allowed for bringing the machine to the stage when it is ready for an acceptance test.
55. The conditions of the test run, its duration and its estimated efficiency.
56. Should the test fail, the time and facilities available to carry out further modifications.
57. Date on which the actual production must commence.
58. Checking over doubtful points, assessing what spare parts are required and the signing of the satisfaction sheets at the completion of the tests and installation.

J. A. Cuckson.

Acomb, York.

The Handsome Designer

TO THE EDITOR OF MECHANICAL WORLD

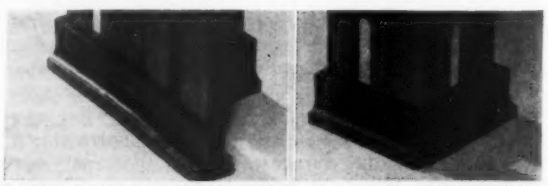
Sir,—Your editorial in the December issue is of very great interest to us in that we are one of the few groups of industrial designers who have, to a certain extent, specialized in the particular function you quote. This service is operated on a consulting basis and during the period of our collective association has been utilized in fields as widely apart as T.V. station design, electronic equipment, laboratory equipment, mailing machines, racing cars, industrial cranes, furniture machinery, duplicators and many others: not forgetting a solitary abattoir.

The Group consists of an engineering/scientist with a strong artistic appreciation, an architect, an advertising/publicity/market research specialist, a textile specialist and a mechanical designer who, together with other free-lance associates have been successful in tackling all problems to their ultimate conclusion. Through the diversity of our collective interests we are able to examine all the many and varied aspects of each and every problem and, in addition to the fundamental aesthetic appearance of the product we can assist the manufacturer in every phase of his design, production, packaging, sales and final advertising campaign.

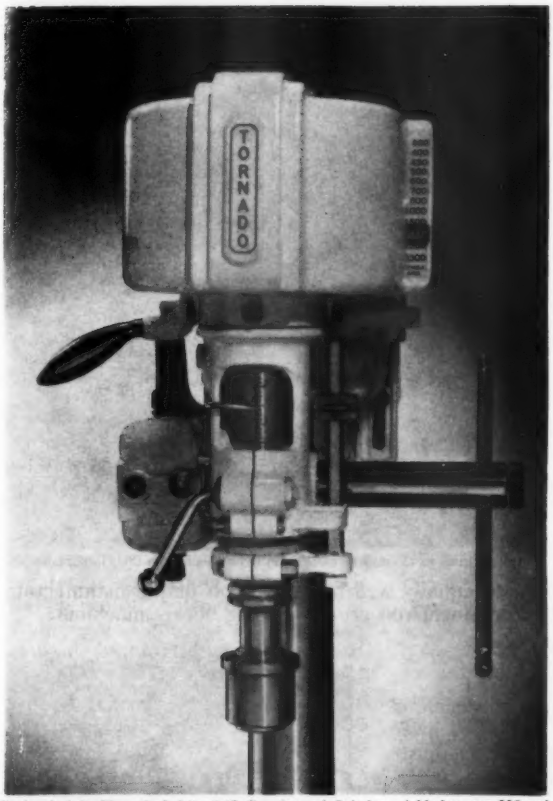
We work in full co-operation with the manufacturers' staff of designers, where they are employed—engineers, production department and sales or advertising personnel. With this vitally necessary co-operation we have been able materially to speed up manufacturing processes or reduce time in getting a new model on the market whilst at the same time, design, based on a proper understanding of engineering fundamentals has made substantial manufacturing economies possible.

Geo. R. Cooper, D.Sc., Ph.D., B.Sc., F.R.S.A.
Associated Design Group.

43, *Fore Street, Hertford.*



PLASTIC BASES FOR ANGLE STRUTS—To prevent floors being marked by slotted angle structures, Handy Angle Limited, Grand Buildings, Trafalgar Sq., London, WC2, have introduced plastic single and double feet for upright struts. Both are bronze finished to match the angle



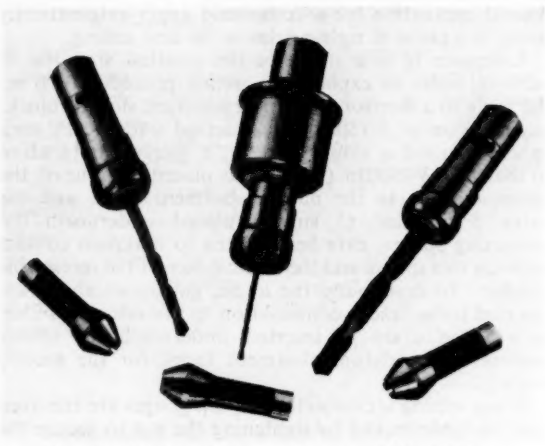
The head of the Tornado 0–½ in. drill. Speeds are infinitely variable between 330 and 3300 rpm

Non-stop Quick-change Drilling with Parallel Shank Drills

A 0-½ in. infinitely variable speed drilling machine incorporating a quick-change collet chuck to enable non-stop drilling to be performed with parallel shank drills has now been introduced by Cooper Bros. (Stockport) Limited, Shrewsbury Street, Stockport. The new machine, the 0-½ Tornado drilling machine and chuck has been the solution to one of the firm's own production problems—that of multi-size deep hole drilling required in the making of provender dies. The chuck incorporates a set of six adaptors and spring collets to cover the range from ⅛ in. to ½ in. including Metric, letter and number sizes. Drills and reamers can be instantly inserted and removed without stopping the machine at speeds up to 1000 rpm without difficulty or danger.

The drilling machine itself is of the hand fed, sensitive type of conventional construction with ball races in the spindle quill assembly and the pulley assemblies. An infinitely variable speed drive between the motor pulley and the spindle, provides a range of all speeds between 330 to 3300 rpm and of which eighteen speeds are indicated by a direct reading scale. The speed change mechanism is operated by moving a lever at the side of the machine cover through an arc of approximately 15°, the speeds being automatically indicated on a scale. The lever itself is held in position by a friction pad and a locking screw is provided.

One particular advantage of this system is that the optimum speed of any particular size of drill can be arrived at by increasing and decreasing the speed during the drilling operation. The correct speed can be easily felt through the sensitive, hand fed lever, and can be registered by direct reading from the scale.



Tornado quick-change chuck and collets for parallel shank drills

Three separate models are available, i.e., a bench mounted drill, a floor mounted drill, and a pillar type on a box base. Ancilliary equipment includes a production type table suitable for suds equipment and with a bigger working surface than the normal standard table and a further table is available fitted with rapid height adjustment.

The Tornado Chuck in standard form has an internal socket to suit all drilling machines with a Jacobs No. 33 spindle. Adaptors can also be supplied separately to convert the chuck to No. 1 or No. 2 Morse taper shank.

The chuck is operated without the use of spanners or keys; it being only necessary to lift a slip ring upwards with the tips of the fingers, insert the tool and draw the slip ring downwards. For removing the tool, the slip ring is once again raised, and the drill withdrawn. Drills or tools with parallel shanks are held in a spring collet, which in turn is held in a screwed adaptor, as illustrated. This in turn has driving slots which engage with hardened steel driving balls in the chuck. These adaptors are suitable for other makes of quick change chucks in general use, and eliminate the necessity for using taper shank drills on sizes less than ½ in.

Improved Hemispherical Compound Angle Sine Tables Accurate to 10′ of Arc

The outstanding feature of the Matrix table is the use of a hemisphere riding in a spherical seating and permitting any angle up to 45° to be set as a single or compound angle. The marked advantages of this design are its greatly increased rigidity, its higher and more lasting accuracy the working surface is always over the centre of the base, and no wear or slackness can develop as in the case of the conventional hinged type.

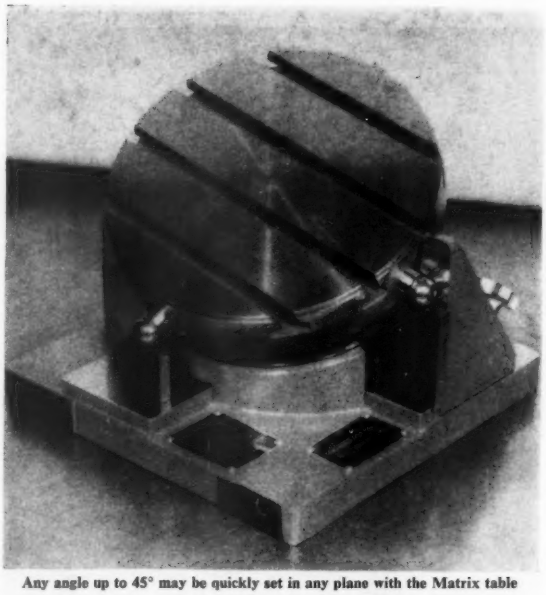
The sine settings are obtainable by the insertion of slip (or block) gauges underneath two hardened precision spheres which are spaced exactly 90° apart, the gauges resting on the appropriate hardened platforms on the base. One of the hardened spheres is located against the vertical face of a detachable straight-edge to ensure that the first inclination of the table is in a plane parallel to

the datum abutment face machined on the base, the second inclination for a compound angle automatically being in a plane at right-angles to the first setting.

Reference is now made to the smallest size, the 9" table in order to explain the setting procedure. To set the table in a horizontal plane a constant slip (or block) gauge value of 3·7500 in. is inserted underneath each sphere. To set a single angle α, a gauge combination to the value 3·7500 in. (95 m.m.) is placed underneath the sphere nearest to the datum abutment faces, and the value 3·7500 in. $-$ (5 sin α) placed underneath the remaining sphere, care being taken to maintain contact between this sphere and the vertical face of the removable bracket. To compound the angle, gauges as above are inserted for α, and a combination to the value of 3·7500 in. $-$ (5 cos α sin β) inserted underneath the sphere nearest to the datum abutment faces, for the second angle β.

When setting is completed the slip gauges are removed and the table locked by tightening the nut to secure the central bolt. This action is assisted by the wedge action of the hemisphere in the seating so that only light pressure is required.

The complete range of Matrix tables, now manufactured by the Coventry Gauge & Tool Company, Coventry, in five table sizes, 9, 13, 18, 26 and 36 in. dia. The upper surface of the hemisphere providing the work-table and with T-slots for clamping purposes can be used equally well for inspection or the manufacture of components on grinding or jig boring machines.



Any angle up to 45° may be quickly set in any plane with the Matrix table

Braked and Direction-locked Castor for Trolleys

A 1-ton capacity castor fitted with manually expanding brakes and eight way direction locking has been developed by Autoset (Production) Limited, Stour Street, Birmingham 18, for industrial trolleys and trucks.

The castor has a push-pull brake operating rod through the pivot spindle to actuate a bell crank lever, the remote end of which is connected to an auxiliary lever attached to the brake lever. Adjustment of the Ferodo lined brake shoes which are housed in the wheel is by an external slotted quadrant.

A means of directional locking is additionally provided by a vertical spring-loaded tommy bar, the lower end of which engages in eight holes equally spaced in a horizontal circular plate forming part of the castor fork head. Tapered roller bearings are used in the swivel housing and wheel hub. With a solid tyre the dynamic capacity of the castor is 20 cwt but if the assembly is fitted with a cast iron rubber tyred wheel the dynamic capacity may be increased to 30 cwt.

An expanding brake is fitted to the 1 ton capacity Autoset castor

Dumper with Articulated Chassis

An articulated chassis of patented design, a major feature of the new Johnson One-20 diesel dumper with a payload of 20 cwt is claimed to provide exceptional stability and manœuvrability under adverse site conditions. The main chassis fabricated from rolled steel channels and suitably reinforced with gusset plates has mounted at the front end a steel shaft 3 in. dia which forms the pivot for the front sub-chassis assembly. This includes the Ackerman steering unit produced from heavy duty alloy steel forgings and operated by Bishop worm and peg type steering box and the skip and skip release mechanism. The inner turning radius is only 4 ft 3 in. and the outer 9 ft 9 in. The dumper is powered by a Lister SL 1 single cylinder cold starting air-cooled diesel engine, govenor controlled to 6·3 hp at 2000 rpm. It has rear wheel drive for maximum traction, and transmission consists of Ford industrial single 7¼ in. dia dry-plate clutch and Power Grip positive drive requiring no lubrication or adjustment. The Ford gearbox provides 3 forward speeds up to 10 mph and reverse, with synchromesh in 2nd and top gear. The makers are C. H. Johnson (Machinery) Limited, Adswood, Stockport, Cheshire.

The Johnson One-20 dumper chassis allows the rear wheels to be raised 2 ft without affecting the skip level

Remote Water Gauge Reading by Television

A simple three-unit water level television system comprising a scanning unit, a cathode follower unit and a display unit has been developed by Hopkinsons Limited, Britannia Works, Huddersfield, for use with prismatic water level gauges of either plate or bulls-eye pattern.

The arrangement of the equipment in the boiler room is shown in Fig. 1. Diffused light from the illuminator fitted behind the water gauge is passed through the prismatic indicator to provide a contrasting light pattern—the steam space appearing as intense clear light and the water column as dull diffused light. Positioned some distance in front of the gauge depending on the type and size of the gauge, are the combined scanning unit and cathode follower unit shown in Fig. 2. The scanning unit houses a lens, scanning disc and photomultiplier. The scanning disc has a narrow slot with variable radius and is rotated at exactly the mains supply frequency by means of a synchronous motor locked to the mains period. The height of the unit is arranged so that the lens is level with the mid line of the water gauge (3 ft 4 in. as standard). In front of the scanning disc is a fixed vertical slot and as the disc rotates, the disc slot and the fixed slot form a gate admitting light at all points through the fixed slot progressively with respect to time. This gated light is projected on to the sensitive surface of a photomultiplier. The voltage produced is transmitted to the display unit, and is transformed back into light by the cathode ray tube. Deflexion of the beam of light on the cathode ray tube is exactly synchronized with the scanning motion.

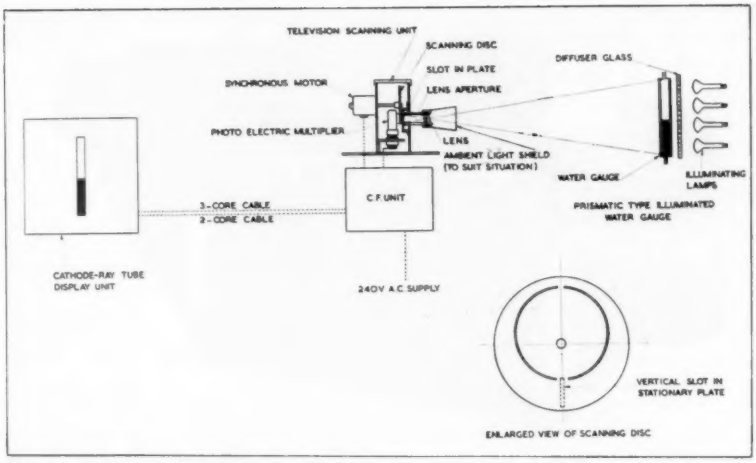
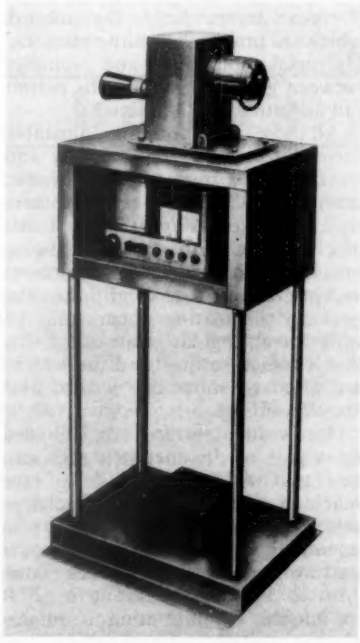


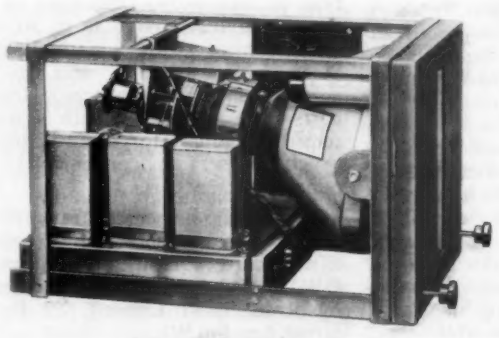
Fig. 1.—Arrangement of Hopkinsons' water level television equipment for boiler rooms and an enlarged view of the slotted scanning disc and plate

Fig. 2.—Combined television scanning unit and cathode follower unit



The photomultiplier is sensitive to the water column in the gauge, since the main light from the illuminator, passing through water, is refracted outside the scope of the narrow vertical slot in the plate behind the lens, and the dull diffused light coming directly through the water column is insufficient to activate the light-sensitive cell of the multiplier.

For all plate gauges with up to 10 in. visibility, the standard camera unit is mounted 8 ft from the gauge face, and with a bulls-eye type indicator with 16½ in. indication, the unit is mounted 13 ft 6 in. from the gauge face, again with the camera set at the same height as the mid line of the water gauge. The standard display unit or receiver Figs. 3 and 4, is mounted in a cradle for easy removal and is connected to the camera unit by an ordinary 2-core and 3-core cable; a co-axial cable not being required. The equipment is arranged for use with 240V a.c. supply, or alternatively a 110V a.c. supply with an additional transformer.



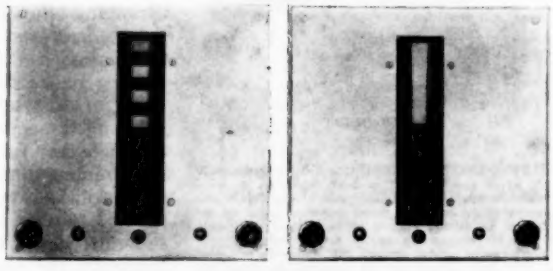
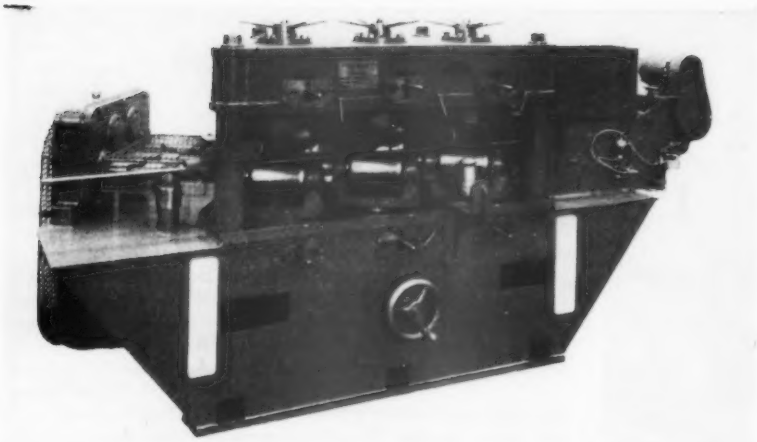


Fig. 3.—(left) The standard display unit with covers removed

Fig 4.—(above) The front of the unit showing the display panel for bulls-eye gauges (left) and ordinary prismatic gauges (right)



Bronx Multi-cross roll tube straightening machine Series 6.CR.4

Straightening 1½in. Copper Tubes

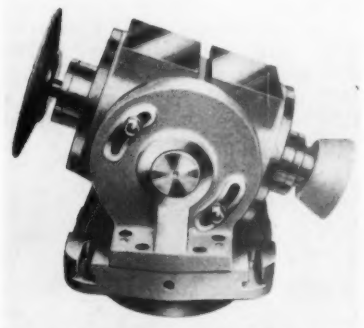
High speed straightening of ferrous and non-ferrous tubes, particularly soft copper or aluminium, from ½ up to 1½ dia is the purpose of the latest Bronx Multi-cross roll tube straightening machine, Series 6CR4 built by The Bronx Engineering Company Limited, Lye, Worcs.

The stock is ideally supported between three pairs of adjustable line contact rolls. All rolls are driven, and as there are no guide bars required between them the material is delivered completely free from surface marks.

The rolls are manufactured from alloy steel, with accurately generated profile and hardened. All rolls are identical and work in roller bearings. The three lower rolls are driven from one 6 hp motor and the three top rolls from another 6 hp motor, the drive being taken from two totally enclosed gear boxes with V-ropes driven from the motors which are fitted beneath the machine. Universal couplings and spindles between gear drives and rolls permit full adjustment of the latter.

All three upper rolls are adjustable vertically to suit tube diameter and working deflexion is applied to the centre roll. The two outer bottom rolls are fixed to the base of the machine, the centre roll also being provided with vertical adjustment and in practice is set to grip the tube between the mating upper roll. All rolls have angular adjustment for line contact setting and indicators are fitted to show the vertical and angular settings.

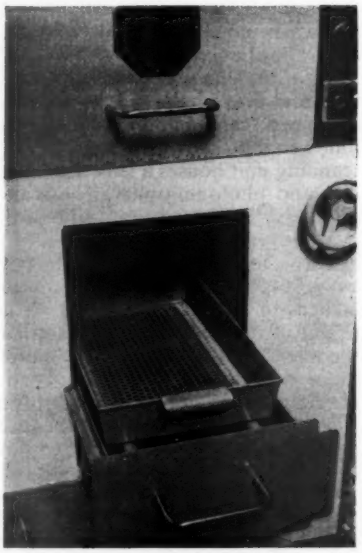
A saw-dust cleaning box followed by a pair of driven pinch rolls can be fitted to the exit side of the machine, between it and a discharge table. The table is fitted with a pneumatically operated hinged cover and will handle all tubes from ½ in. to 1½ in. diameter up to 20 ft in length. By mounting a photo-electric cell on the machine and arranging the light-beam between the centre and outgoing rolls, a tube passing through the machine breaks the light-beam which causes the pinch rolls to open and the hinged cover to close. When the end of the tube passes through, the uninterrupted light-beam causes the rubber covered pinch rolls to nip the tube and pull it clear of the saw-dust clearing box. Simultaneously the hinged cover is raised and the tube discharged down the discharged table ramp, on to a suitable stacking unit or table.



TILTING CUTTER GRINDER.—This self contained unit which can be tilted in both directions up to a maximum angle of 15° either side of the centre line incorporates a balanced motor mounted direct on the spindle. To enable cutters to be ground accurately at the correct cutting angles at one operation the spindle can be rotated through 306° and being extended at both ends wheels can be mounted at either end according to the application. The constant speed on a 50 cycle mains supply is 3000 rpm. The unit made by Boneham & Turner Limited, Nottingham Road, Mansfield, Notts is available for all types of existing tool and cutter grinding machines

Detachable Hose Couplings

An important addition to the Dunlop range of flexible pipes, is the introduction of re-usable detachable couplings. As a result, users will now be able to make up their own pipe assemblies to the required length. Designed for use with hose whose working pressures are between 1000 and 5000 psi, the couplings also increase the life of the assemblies by enabling worn hose or damaged couplings to be replaced. Full details are available from the Industrial Wire Braid Department, Dunlop Hose Division, St. George's Road, Coventry.



New screen tray for Roto-Finish DW.16-16-2 machine

Separating Screen for Barrelling Machine

Now adopted as standard equipment for the Roto-Finish Midget barrelling machine (DW 16-16-2) is a new type of screen tray consisting of a sheet steel tray, the base of which is perforated with square holes. Stronger construction and more accurate separation of chips from parts than is possible with a wire screen is claimed for the new trays which also serve as convenient containers for the parts.

A set of six screen trays with different sizes of screen is provided as standard equipment with each DW 16-16-2 machine manufactured by Roto-Finish Limited, 39 Park Street, London W1.

Progress in Cargo Handling. Vol. 2. London, 1958; Illiffe & Sons Limited. 63/- net (by post 64/4). 306 pp. 6×9½ in.

This volume contains the reports of papers and the discussions of the General Technical Conference of the International Cargo Handling Co-ordination Association, held in Hamburg in 1957. The importance of its subject matter arises out of the fact that as much as half the total cost of maritime transport is incurred while ships are in port. Much has already been done to expedite cargo handling in transit sheds, but there is room for improvement on board ship and it is this with which the book is concerned. The remedy lies only partly in mechanization for cargo arrangement offers scope for improvement, and there is obviously much that can usefully be done by the use of containers of economical size for certain kinds of merchandise. There are details of organizations, like cargo working, which by rationalization can facilitate handling of cargo. Altogether the book is a compendium of experience gained by experts and is of first importance to those concerned with the particular purpose. It also has a wide potential interest for those concerned with the handling and control of large quantities of products for it offers many useful parallels and contrasts to stimulate ideas and efficiency.

Pennine Journey. By William B. Stocks. Huddersfield, 1958; The Advertiser Press Limited. Price 5/- net (by post 5/5). 96 pp. 5½ × 8½ in.

For students of transport history and particularly for those living in the West Riding of Yorkshire, Mr. Stocks's little book will be a welcome guide to their researches. Centred on Huddersfield, a town which has owed its prosperity to textiles, engineering and chemicals the author traces the growth of transport from the early days of mail coaches, canals and their tram road feeders to the construction of the first railway to Huddersfield in 1845. From that date railway schemes followed in rapid succession, many involving considerable civil engineering works in order to negotiate the difficult terrain. Minor railways and the steam and electric tramway systems of the district are dealt with at some length and the book concludes with an appendix of relevant events and facts. The book contains a number of interesting photographs and illustrations.

World literature on heat transfer.—Twelve thousand references to published papers and books on all aspects of heat transfer and related subjects are included in the latest edition of the "MERL Heat Bibliography". It contains references to heat transfer by conduction, convection and radiation; boiling, condensation and evaporation; heat exchangers of various kinds; and physical properties such as entropy, specific heats, thermal conductivity and viscosity. The references were obtained from original publications and abstract journals; all titles noted in MERL during 1955 and 1956 which appeared to be relevant are listed. The titles are printed under a simple subject classification which avoids cross-referencing. Copies of the Bibliography are available from the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

books

Summaries of research at MERL.—The Mechanical Engineering Research Laboratory D.S.I.R. is preparing short summaries of the results of recent research of direct industrial interest to help firms to keep in touch with its work. They will give straightforward accounts of work still in progress at MERL as well as the main findings of completed investigations. They are intended for circulation to senior management as well as to design and production staff. Among subjects covered from time to time will be: fatigue and creep of engineering materials and components; bearings, lubrication and wear; performance of gears and other mechanisms, engineering metrology and noise control; design and performance of hydraulic machinery; heat transfer and applied thermodynamics; and machining, extrusion and other metalworking processes. Engineers and industrial organizations who would like to receive copies of MERL Research Summaries are invited to send their names to: The Director, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.

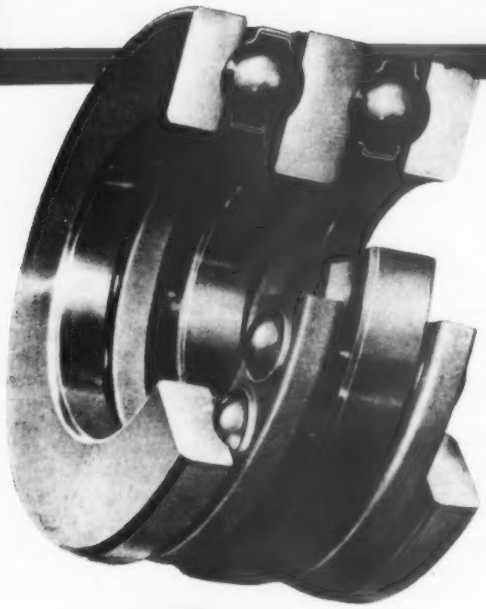
Cast iron research.—A variety of research is described in the 37th annual report of The British Cast Iron Research Association, Alvechurch, Birmingham. An extensive programme of tests on the suitability of different types of cast iron for steam engineering applications is in progress, and work continues on problems associated with the factors governing the soundness of iron castings. Other work in hand concerns the properties of clay-bonded sands at high temperatures, analytical techniques, the moculation of white and chilled irons, corrosion, graphite formation, and hydrogen pick-up. In addition to research the association operates a development department, a foundry operations section and an intelligence department.

Instructional chart for Herbert Capstan.—Throughout its existence the Herbert No. 4 Capstan Lathe has proved ideal as the basic lathe for instructional purposes in schools, colleges and universities, in government training centres, industrial apprentice training schools, and in industrializing backward countries, An instructional chart (40×30 in.) for the Herbert No. 4 is now available price 15/- post free from the Technical Education Department, Alfred Herbert Limited, P.O. Box No. 30, Edgwick Works, Coventry.

Human problems in industry.—The report of the joint D.S.I.R.—Medical Research Council Committee on Human Relations in industry final report (H.M.S.O., 3/3 post free) says that an increasing number of scientists must be trained to carry out social research in the industrial environment, and that governmental financial support should have more continuity than in the past. The report expresses the view that social research work in industry should satisfy other than purely economic needs and human relations are important in their own right. But it is desirable that productivity should be an important object of study and that the results of human relations research should be applied to that end.

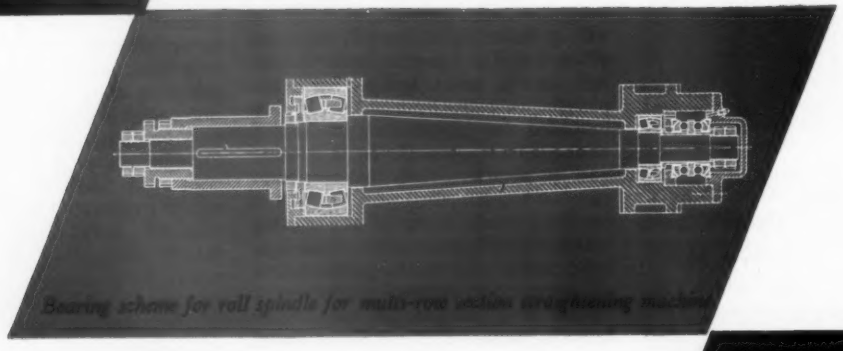
Hammers, good and not so good.—The current edition (No. 7) of "Shoppers Guide" issued by The Consumer Advisory Council has an account of an investigation into a number of hammers bought in the ordinary way in ironmongers' shops and stores. The report gives a completely clean bill to only two of them and the dearest was the most satisfactory.

Only SKF can offer such a wide selection of British made bearings

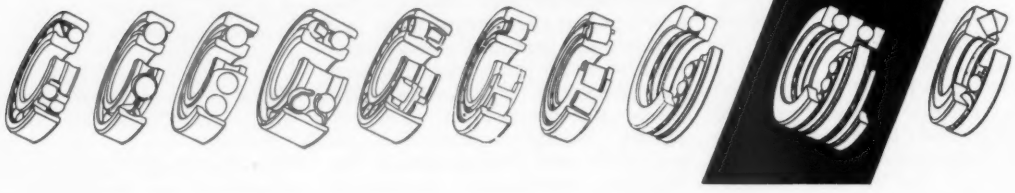


Where exclusively axial loads are to be dealt with acting in either direction, the double thrust ball bearing may be used. This bearing has two rows of balls, one for thrust in each direction. The centre ring is the shaft ring in metric sizes ; the housing rings may have either a flat or sphered seating. In inch sizes the centre ring is the housing ring.

This is one of the ten variants of the four basic rolling bearing types ; Skefko is the only British manufacturer making all four and can therefore offer completely unbiassed advice on the choice of bearing types for any specific problem.



Bearing scheme for roll spindle for multi-row section straightening machine



THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES : BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G182A

BUSINESS & PROFESSIONAL

Personal

Mr. Leslie Ingham, formerly manager of the industrial sales division, has been appointed assistant sales manager of Chloride Batteries Limited of Grosvenor Gardens House, Grosvenor Gardens, London, SW1., for the sales of all types of batteries in the United Kingdom and overseas.

SIMMS MOTOR UNITS LIMITED announce that **Mr. Wilfrid Newland,** previously personal assistant to the managing director, and also associate director in charge of export, now becomes commercial director. **Mr. Harold George Dunn, M.I.Mech.E., M.S.A.E.,** also joins the board. Mr. Dunn joined the company in 1934 and was appointed an associate director in January 1958.

BRITISH INSULATED CALLENDER'S CABLES Limited announce the appointment of **Mr. G. N. Blades, A.M.E.M.E.,** as regional manager London in succession to **Mr. E. A. Sayers,** who retired on December 31, 1958. Mr. Blades was formerly divisional sales manager (rubber cables) at the Leigh Works and this position has been taken by **Mr. D. I. S. Hinton, B.A. (Mech. Science),** formerly B.I.C.C. sales engineer (aircraft).

Mr. K. S. Phillips, B.Sc.(Eng.), A.C.G.I., A.M.I.E.E., has been appointed sales controller of Research and Control Instruments Limited, and is responsible for the co-ordination of all sales staff activities.

Mr. Arnold Carr, assistant managing director of Thos. W. Ward Limited, Albion Works, Sheffield, has been appointed deputy chairman of the company. **Mr. Douglas F. Walton** has also been appointed a director.

NU-WAY HEATING PLANTS announce that, following a complete re-organization of its training facilities, **Mr. H. W. Burbery,** formerly the company's installation and service manager, has been appointed principal of the Nu-way school of oil firing. Details of the regular courses, which are free, may be obtained from the bursar, Nu-way school of oil firing, Vines Lane, Droitwich.

G. A. HARVEY & COMPANY (LONDON) Limited, have recently made the following staff appointments. **Mr. K. Tardif,** publicity manager, has now taken over the duties of home sales manager and will continue to operate from the company's head office at Greenwich. **Mr. H. Barker,** formerly deputy sales manager, has been appointed export sales manager and will also operate from Greenwich. **Mr. H. F. Jones** has been appointed London area manager controlling the company's London sales office at 58, Victoria Street, London, SW1.

THE retirement from Siemens Edison Swan Limited, is announced of **Mr. E. A. Beavis, B.Sc(Eng.), A.C.G.I., M.I.E.E.,** chief engineer of the power cable division, after 45 years at the Woolwich Works. Mr. Beavis was in charge for a period of the original cable test room at the age of only 21, and went on to play a large part in the development of power cable techniques. He was associated with the design of Pluto, the oil carrying pipeline of the Second World War, involving internal pressures of 750 lbs/sq in, and a 3-inch diameter cable.

THREE directors to the board of the parent company of the Hadfields Group of companies, Hadfields Limited, East Hecla Works, Sheffield, have been appointed. **Mr. Fred Cousans, F.I.M.,** foundry superintendent; **Mr. George Wood, A.MET., A.I.M.,** assistant research manager; **Mr. R. C. Heys,** present managing director of Millspaugh Limited, subsidiary company of Hadfields Limited.

Mr. Henry L. Hirchberg has gone to Australia to take up a new appointment as director and works manager of Ediswan-Ekco (CRT) Company, Sydney, New South Wales. He has charge of a 60,000 sq ft works that has been running as a pilot plant for a year. He will co-ordinate expansion plans to meet the needs of Australia's domestic T.V. tube market.

Mr. G. D. Elliot, O.B.E., has been appointed deputy general works manager of Appleby-Frodingham Steel Company, a branch of The United Steel Companies, Limited. He will succeed **Mr. J. D. Joy** as general works manager on April 1 next. Mr. Joy became deputy general manager of the company on January 1. **Mr. N. D. MacDonald,** superintendent of Appleby-Frodingham's ore preparation plants, is to succeed Mr. Elliot as works manager (iron).

Mr. Fred Walker, methods engineer at Fort Dunlop in Birmingham, has been appointed manager of the Dunlop company's overseas engineering department. Mr. Walker, who is 39, has been with Dunlop 20 years.

METROPOLITAN-VICKERS ELECTRICAL Company Limited announces the appointment of **Mr. B. Dawkins, B.Sc.(Eng.), A.M.I.E.E.,** as assistant manager of the education department for professional and technician apprentice recruitment and training. Other appointments include those of **Mr. E. W. Stainton, B.Sc., A.C.G.I., A.M.I.E.E.,** assistant sales manager, switchgear department; **Mr. D. R. Clegg, Assoc.Mem.I.M.E.M.E.,** assistant sales manager, transformer department; **Mr. F. H. Davis, M.Sc.(Met.).,** assistant superintendent foundries; **Mr. D. E. Thornhill, B.Sc.Tech.,** assistant superintendent, transformer department, Wythenshawe. The A.E.I. turbine generator division has appointed **Mr. P. A. J. Manley** as assistant superintendent, large turbine department, Trafford Park.

ENGLISH STEEL CORPORATION LIMITED announce that **Mr. W. E. A. Redfearn** has been appointed a director with effect from January 1, 1959. Mr. Redfearn is deputy managing director of English Steel Forge and Engineering Corporation Limited, and a director of English Steel Rolling Mills Corporation Limited.

Mr. W. Forbes Ritchie, until recently chief engineer of the Consolidated Pneumatic Tool Company at Fraserburgh, has been appointed manager of factory operations. In recent years the company has augmented its output at Fraserburgh by a further large factory at Aberdeen, an extension of production in South Africa and the opening of a new manufacturing unit in India. This is in addition to existing plants on the continent and in Australia. In his new position, Mr. Forbes Ritchie will be responsible for the overall supervision and co-ordination of manufacturing operations in all these centres.

Mr. John T. Golby has resigned from the boards of W. E. Sykes Limited of Staines and associated companies, and from his position as sales director of the group, and has been appointed managing executive of the company's Australian branch for a term of two years.

Mr. F. L. Gibson, who joined Wolf Electric Tools Limited eight years ago, has been appointed sales manager for the home market.

STEELE AND COWLISHAW LIMITED, Stoke-on-Trent, specialists in dispersion, grinding and mixing equipment and flexible couplings, announce that **Mr. F. Limb, O.B.E.,** has resigned from the position of managing director. **Mr. J. B. Capey,** previously director and general manager, succeeds Mr. Limb, who remains on the board of the company.

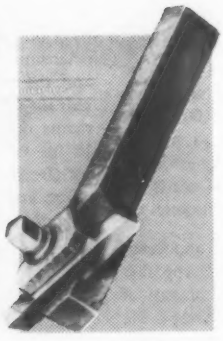
Mr. J. Horridge, works manager of George Kent Limited since 1951 who is retiring early this year on medical grounds, has

Eclipse

TOOL HOLDERS with precision features

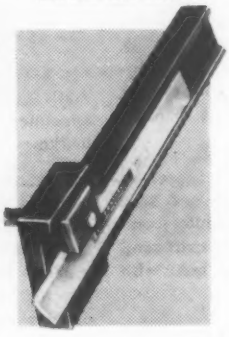
Right-hand tool holder

Straight tool holder



Left-hand tool holder

American type for slotted pillar tool post



Cutting off tool holder

use them with

ECLIPSE TOOL BITS to make the perfect cutting combination

. . . . No ordinary tool holders, these! They have patented clamps with sideways and downwards pressure for the firmest grip. The tool seating is precision machined and openly accessible for easy cleaning, thus giving perfect tool seating and eliminating vibration which may lead to "chatter". "ECLIPSE" are precision holders for precision work and with "ECLIPSE" Tool bits they offer the finest combination for speedy and accurate production.

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

been presented with a farewell gift subscribed for by friends in the Kent factories at Luton, Hitchin and Resolven, South Wales. Owing to the retirement, the company has had to re-organize considerably on the works' side and **Mr. J. F. Willsher** has been appointed general works manager.

THE appointment is announced of **Mr. Peter G. Mellor** as an area representative of Whitehouse Industries Limited, Philidas Division. His address is Little House, 9 Burwood Park Road, Walton-on-Thames. Telephone: Walton-on-Thames, 2443.

Mr. R. J. W. Rudkin, B.Sc., M.I.N.A., general manager of the naval yard, of Vickers-Armstrongs (Shipbuilders) Limited and **Mr. A. L. White, M.B.E.,** general manager of the Palmers Hebburn Works, have been appointed additional directors of Vickers-Armstrongs (Shipbuilders) Limited.

Mr. Harry Willshaw, chief consulting engineer of the Dunlop Rubber Company and general manager of Dunlop Advisory Services Limited, was awarded the Hancock Medal for 1958 by Sir John Dean, president of I.R.I., at Manchester. The Hancock Medal is awarded for conspicious services to the rubber industry.

Mr. A. J. Faux, a former joint general manager of Lloyds Bank, Limited, and **Mr. J. D. Nuttall,** financial director of Triplex Holdings, Limited, have accepted invitations to join the board of Isetta of Great Britain, Limited.

Mr. George S. Sanders, B.Sc.(Eng.), A.C.G.I., A.M.I.Mech.E., aged 38 years, has been appointed head of the newly formed group productivity services department of the Solartron Electronic Group, Limited, Thames Ditton, Surrey.

Dr. W. Davies, head of the minerals section of the research and development department of The United Steel Companies Limited, has been additionally appointed geological consultant. **Mr. I. M. D. Halliday** will be formally in charge of continuous casting research. **Mr. C. Holden** is appointed head of the furnace research section, formerly known as the furnace design section. **Mr. A. S. Babb** is to take charge of a new trackwork and structures section in the department; this will form a part of the development engineering group. **Mr. D. Shaw** is appointed head of the newly created electronics section.

Mr. R. H. Williams, formerly manager of the Univac computor division of Remington Rand Limited, is now managing director of Computer Consultants Limited, management consultants specializing in the use of electronic computing systems for commercial work. The address is Hirnant, Dolgelley, Merioneth. Tel. Dolgelley 177.

Obituary

WE regret to record the death of **Mr. Richard Lloyd,** a director of The Effingham Steel Works Limited, and London area manager of their associated firm, Marsh Brothers & Co. Limited.

WE regret to record the death, after a prolonged illness, of **Sir Jackson Millar, C.B.E., D.L.,** chairman since 1946 of Albion Motors Limited, and a director of Leyland Motors Limited and Scammell Lorries Limited as well as a number of other companies.

WE regret to record the death of **Mr. William Elkington Wright, F.C.S.,** late director of The Pyrene Company Limited. He was responsible, primarily for the metal finishing division of the organization and joined the company nearly 30 years ago.

Addresses

THE name of G. & J. Weir Limited has been changed to G. & J. Weir Holdings Limited, and the Cathcart trading undertaking has been transferred to a new subsidiary company with the name of G. & J. Weir Limited, as given up by the parent company. The parent company will now operate as a holding company under the direction of the present board. The board of the new operating subsidiary company is Hon. J. Kenneth Weir, C.B.E., B.A., chairman; J. Russell Lang, managing director; J. W. Atwell, M.Sc., deputy managing director; A. C. Smith, sales; J. J. B. Young, C.A., finance; Gavin Milligan, works; R. S. Silver, D.Sc., technical. The secretary of the new company is Mr. Harvey Waugh, F.C.I.S.

OZALID COMPANY LIMITED have moved all their head office administrative department to their new factory at Langston Road, Loughton, Essex. Telephone: Loughton 5544.

BRITISH INSULATED CALLENDER'S CABLES Limited announce that their Worcester branch office has been allocated another telephone number—Worcester 6074 additional to their present one, Worcester 2070. The Norwich branch office address is changed to 56 Pitt Street, telephone number Norwich 21526. The amendment to the Cardiff Office address is now in force and is Station Terrace, Queen Street, Cardiff. Telephone number Cardiff 24716.

DURHAM RAW MATERIALS LIMITED, Manchester Office has moved to Canada House, 3 Chepstow Street, Oxford Street, Manchester 1. Telephone: CENtral 2683. Mr. Dennis Punton has been appointed manager of the Manchester office.

I.T.D. LIMITED of Webb Lane, Hall Green, Birmingham 28, have completed most of their departmental address changes and in addition to their Birmingham address, have Sales offices at Water Road, Abbey Estate, North Circular Road, Wembley, Middlesex. Correspondence for the general sales manager (Mr. A. C. Cooper) should for the present be directed to the Water Road address.

A SEPARATE company to handle machine tool activities has been formed by T. B. Pearson & Sons Limited, of Walker, Newcastle upon Tyne. It will be known as Pearson Machine Tool Company Limited, and will operate from Wincomblee Road, Walker, Newcastle upon Tyne.

THE OWEN ORGANISATION has formed a new company to serve its interests in India, Mahindra Owen Private Limited, Gateway Building, Apollo Bunder, Bombay, 1, India. Telephone No. 219131.

NEW agents for Scotland for Curnon Engineering Company, Claude Road Works, Chorlton, Manchester, manufacturers of recording flow meters, are the Industrial Process Equipment Company, 22, Pitt Street, Glasgow, C2. Telephone CENtral 0056/7. (Mr. N. Provand, A.I.E.E., M.I.P.E.).

Contracts and Work in Progress

DUNLOP RIM & WHEEL COMPANY.—Contract worth £469,150 from the Czechslovak Government for the supply of semi-automatic production lines for the manufacture of passenger car and commercial vehicle rims.

MIRRLEES, BICKERTON & DAY LIMITED, Stockport.—Canadian order value £250,000 for four 3000 hp diesel engines.

BRITISH INSULATED CALLENDER'S CABLES Limited.—Indian Railway contract worth approximately £2½ million for the supply and installation of 25 kV 50-cycle single-phase a.c. overhead equipment. About 60% of the contract value will be spent in Indian currency on locally manufactured materials.

THE INCANDESCENT HEAT COMPANY Limited, Smethwick.—Annular hearth rotary furnace to be installed in Northern Italy. The furnace will be fired by the Incandescent Equiverse system using natural gas. Approximate value half a million pounds sterling.

TI (EXPORT) LIMITED.—Contracts for steel tubes exceeding £1¼ million in value received from the China National Metals Import Corporation.

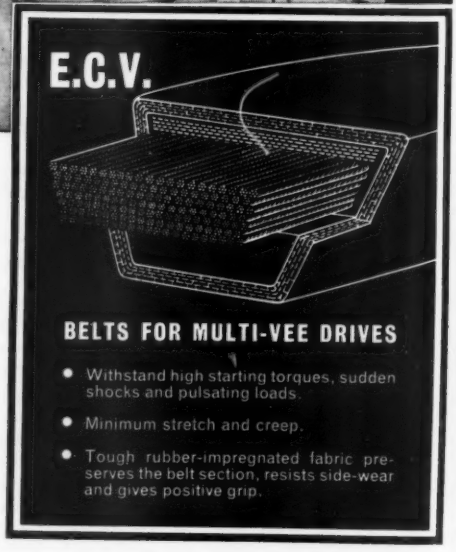
GEORGE KENT LIMITED, Luton.—Order for a further 32,000 water meters for the Teheran Water Authority.

ASSOCIATED ELECTRICAL INDUSTRIES Limited, Heavy Plant Division.—Contract from the Appleby-Frodingham Steel

Greater V-Belt reliability means more productivity

YOU CAN'T RISK costly shutdowns on full-scale production jobs – that's why Goodyear belts are the wisest choice for Multi-Vee drives. They can be fitted and forgotten – there's no better testimony to their trouble-free operation! There's a range of these 'job-designed' Goodyear V-Belts to give longer service and more efficient transmission on every type of drive.

The Goodyear Technical Man will gladly advise on the right belt for any job.


E.C.V.
BELTS FOR MULTI-VEE DRIVES
• Withstand high starting torques, sudden shocks and pulsating loads.
• Minimum stretch and creep.
• Tough rubber-impregnated fabric preserves the belt section, resists side-wear and gives positive grip.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS

CONVEYOR BELTING · V-BELTS · TRANSMISSION BELTING · HOSE

Company, Scunthorpe, for supply and erection of the electrical main drive equipment for a new 12-ft twin-motor reversing plate-roughing mill to roll slabs weighing up to 25,000 lb.

AUTOMATIC TELEPHONE & ELECTRIC Company Limited.—Contract for private automatic branch exchange to accommodate eventually 7000 lines for London headquarters of The Shell Petroleum Company Limited, now being built on the South Bank of the Thames.

THE BRONX ENGINEERING COMPANY Limited.—Order value £32,000 from V/O Stankoimport, Moscow, for eight tube straightening machines.

METAL INDUSTRIES LIMITED.—Order for seven cranes for the Port of London Authority to be supplied by Stothert and Pitt Limited, with controls by Igranic Electric Company of Bedford.

Order for large hydraulic wool baling press for D. B. Walker & Company of Karachi, Pakistan, to be supplied by Fawcett Preston & Company of Bromborough, Ches.

THE SHELL PETROLEUM COMPANY LIMITED.—160 mile 20 in. pipeline from the S. Borneo oilfield to the coast at Balikpapan, will be laid by Williams Brothers; the constructors are John Brown Limited, London.

New Wolf Indian Company

A NEW industry was started in India two years ago by Wolf Electric Tools Limited and their Indian agents, Rallis India Limited, for assembling a limited range of Wolf electric tools, partly from components from England, but utilizing wherever possible local sources for other materials. A new company, Ralliwolf Private Limited, has now been registered and building operations for a new factory at Mulund, near Bombay, are already under way.

Electrical Companies Merge

A NEW company, Brookhirst Igranic Limited, has been formed by Metal Industries Limited for the closer association of its two electrical subsidiaries, Brookhirst Switchgear Limited of Chester and Igranic Electric Company Bedford.

Goodyear New Division

A NEW sales division has been created by the Goodyear Tyre & Rubber Company (Great Britain) Limited, to be termed General Products Division, which will incorporate industrial rubber products, shoe products, films and adhesives and chemical products. Mr. K. H. Johnston, A.M.I.P.E., who has been appointed sales manager of the new division has wide experience in these specialized fields. He joined Goodyear in 1951 and served in India, Burma and Ceylon, where he held a number of managerial appointments.

Clare Collets in Scotland

SOLE agents for Clare Collets Limited milling equipment for the whole of Scotland are Messrs. Stuart and Houston, 5 York Street, Glasgow C2. Full stocks of Clare milling equipment will be available together with a comprehensive technical service for all milling problems.

Bending Machine Distributors

SOLE distributors for the Swiss-made "Rival" conduit bending machine in the United Kingdom are Chamberlain Industries Limited of Staffa Works, Staffa Road, Leyton, London E10.

NEW BELTING SYMBOL.—The new "t" symbol under which all belting products of Turner Brothers Asbestos Company Limited of Rochdale, Lancs. will in future be marketed. The down stroke of the "t" symbol is a conveyor belt section and the cross sectional piece represents a V-belt

Instruments Agency

REPRESENTATION for London and South-East England of Electronic Switchgear (London) Limited has now been taken over by Industrial Instruments Limited, 32, Buckingham Palace Road, London, SW1. (Telephone VICtoria 0657), who have relinquished the representation of West Instruments Limited.

George Cohen Acquisition

THE offer of the George Cohen 600 Group Limited to acquire all the 1,600,000 shares in the capital of G. Beaton & Son Limited at the price of 4s. per share has been accepted by the holders of more than 91 per cent of the shares and the offer has accordingly become unconditional.

Ciba Fellowships

THE CIBA Fellowship Trust has been founded for the purpose of improving and increasing the interchange of ideas between scientists in the United Kingdom and on the Continent. Several Fellowships will be awarded to graduates of British Universities for tenure during the academic year 1959-60 at Continental universities or institutions for research in chemistry, physics or some other allied scientific subject. Details are available from the Secretary of the CIBA Fellowship Trust, CIBA (A.R.L.) Limited, Duxford, Cambridge.

Film News

Permali Progress.—A new film produced by 'The Big Six Film Unit' showing the latest techniques and equipment employed for producing densified wood laminates 'Permali', 'Hydulignum', and 'Jabroc', the manufacture of Dialam high voltage bushings and production of the newer materials, Permaglass laminates, Permaflon processed P.T.F.E. and Permacast insulation. Running time 20 min., black and white, 16 mm sound. Further particulars from J. G. Millar, Permali Limited, Bristol Road, Gloucester.

The Care and Maintenance of Conveyor Belting.—In the making of this film the Dunlop Company received valuable help from the National Coal Board. It is intended for mining and factory managers and engineers and for general industry. Produced by Technical and Scientific Films Limited, it runs for 29 min and black and white copies in 16 mm are available on free loan from The Dunlop Film Library, Wilton Crescent, London SW19.

New Institute

To cater for mining engineers residing in the South of England a new institute, The Southern Counties Institute of Mining Engineers, has been formed. It is affiliated to the Institution of Mining Engineers and the address of the secretary is Hobart House, Grosvenor Place, London, SW1. The first president is Dr. H. L. Willett, deputy director-general of production (safety and techniques) of the National Coal Board. Details of qualification for membership can be obtained from the institute secretary at the above address.

Diesel Agreement

Two diesel engine manufacturers—The English Electric Company Limited and W. H. Dorman Limited, of Stafford, have entered into an agreement for the joint promotion of each company's products.

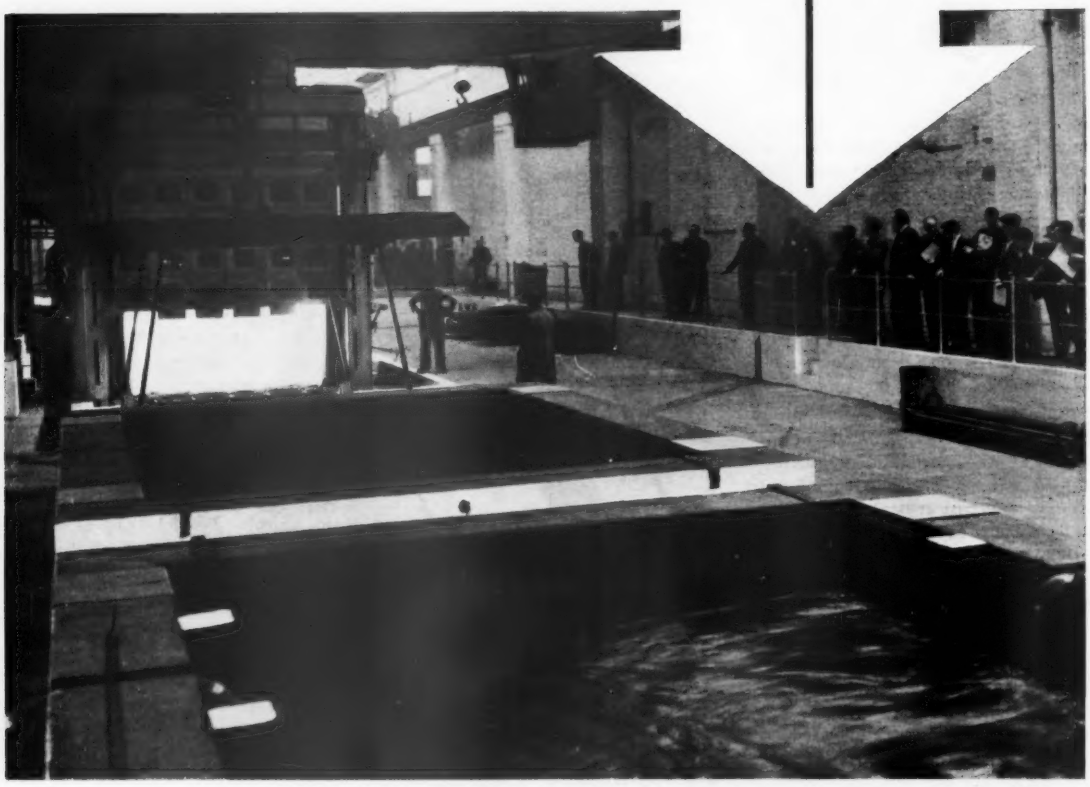
Invicta-Hydetsco

THE hydraulic open-sided planers previously known as Hydetsco will in future be sold under the name Invicta-Hydetsco as they are now a product of The B. Elliot Group.

Schiess Machines

SOLE British agents appointed by Schiess AG of Dusseldorf-Oberkassel for their precision gear hobbing machines, horizontal pinion hobbing machines, and vertical gear shaping machines, are Sykes Machine Tool Company Limited of Staines, Middlesex.

They all stopped to look



When a group of Foundry Technicians and Executives recently visited the Edgar Allen Steel Foundry, their main interest was the latest conception of the art of quenching. This takes the form of a three-stage batch quenching furnace for the treatment of carbon, austenitic (11-14%) manganese and alloy steel castings, and a new method of insuring prompt efficient contact of the castings with the quenching medium. The installation of this up-to-date and efficient equipment is another great step forward in Edgar Allen & Co. Ltd.'s constant aim—'Quality Improvement'. The purpose behind it?—YOUR interests! Range of products illustrated in our Steel Foundry Book. May we post you a copy?

To Edgar Allen & Co. Ltd. Sheffield 9.
Please post "Steel Foundry Book" to

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Nuclear use for 'dag'

The fifth number of the newspaper-format publication *Prospects* features articles on several nuclear energy applications for 'dag' products. These include the treatment of Berkeley bellows units and Bradwell heat exchangers.

Other subjects include the use of Aquadag colloidal graphite in water in a new heating element known as Mhoglas, the value of 'dag' Product 529 to Bristol aero-engines and the cutting efficiency tests carried out on MoS_2 treated files. Copies of *Prospects* No. 5 can be obtained from Acheson Colloids Limited, 70 Hill Street, Richmond, Surrey.

Automatic Control of Open-hearth Furnaces

The three most important factors affecting the operating efficiency of the open-hearth furnace are refractory life—dependent on roof temperature, combustion efficiency and a constant furnace-pressure value. Publication 2022 issued by George Kent Limited, Luton, Beds. shows how their instruments and automatic control equipment are applied to the different variables associated with open-hearth furnaces to give increased production at optimum efficiency.

Keyway Broaching Equipment

An increase in the capacity range of the Marlco keyway broaching sets is announced by W. H. Marley & Company Limited, 105 High Road, London, N11. The entire range of keyways from $\frac{1}{16}$ to $\frac{3}{4}$ in. keyways in bores from $\frac{1}{4}$ to $\frac{3}{4}$ in. is now covered by four sets of broaches and guides using practically any type of arbor press. Additional guides are available for taper keyways. Full details of the four sets are contained in a leaflet.

Rubber and Synthetic Roller Coverings

A new publication by Dunlop Rubber Company Limited (General Rubber Goods Division), Cambridge Street, Manchester 1, embraces all the materials used for roller coverings. They include natural rubber, butyl, nitrile, neoprene, ebonite, silicone rubber and P.T.F.E. Aspects of roller design and contruction influencing the coverings are discussed as are recommendations for subsequent operation, storage and re-grinding. Guidance as to the use of the coverings in the tanning, printing, paper and leather cloth embossing industries are also given.

Air-operated Automatic Controllers

A publication outlining the suitability of air-operated proportional automatic controllers for industrial processes is issued by Negretti Zambra Limited, 122 Regent Street, London W1. It describes the wide range of controllers available, their mechanism and their application in process control.

Jack Replacement Service

To obviate inconvenience and delay while repairs to jacks are taking place, Richard C. Gibbins & Co. Limited of Berkley Street, Birmingham, offer a replacement service for their G.P. jacks.

Under this scheme damaged jacks are immediately replaced from stock with a fully tested and certified reconditioned jack. The only charge made is the cost of repairing the damage to the G.P. jack which has been returned by the user.

Crane Weighers

One of the most popular applications for the Salter No. 99 crane weigher is weighing cupola charges and the melt in the foundry. Geo. Salter & Company Limited, West Bromwich make the No. 99 weighers in all capacities ranging from the smallest $\frac{1}{2}$ cwt to 10 cwt up to a 5–100 ton model. Full details are contained in a newly published booklet.

Trade Literature

High-temperature Adhesives. Technical Notes 188

Published by CIBA (A.R.L.) Limited, Duxford, Cambridge, Technical Notes 188 is devoted to metal-to-metal bonding for high speed flight conditions. Extremely severe service conditions have created a demand for adhesives to withstand high temperatures. In this article by C. N. Powis of CIBA (A.R.L.) Limited the developments made to meet these new circumstances are reviewed.

Masonry Drills and Screw Fixing

Tungsten carbide tipped drills have now been added to the Philplug range of products. Marketed by Expandite Limited, Chase Road, London NW10 and Secomastic Limited, Western Road, Bracknell, Berks, these drills which are made in eight sizes from $\frac{5}{32}$ to $\frac{1}{8}$ in. plus $\frac{7}{16}$ and 1 in. dia should greatly extend the scope of the Philplug screw fixing method to bricks, tiles and stonework.

Carbide Tipped Circular Saws

Full details of Speedicut Mitia carbide tipped circular saws are given in leaflet No. 213 issued by Firth Brown Tools Limited, Speedicut Works, Carbide Street East, Sheffield 4. These saws are suitable for cutting plastics, abrasive hardwoods, asbestos, non-ferrous metals, graphite, etc. Brief details are also given of the Mitia saw sharpening machine.

Pumps for Industrial and Marine Duties

To convey some impression of the vast range of pumps manufactured by Sigmund Pumps Limited, Team Valley, Gateshead 11, a brochure has been prepared which shows their pumps in service at home and abroad in waterworks, oil refineries, chemical works, mines and research stations.

Gas Analysers—Control and Instrumentation

List 144/C issued by the Cambridge Instrument Company Limited, 13, Grosvenor Place, London SW1, describes a range of indicators, recorders, and controllers for use with Cambridge automatic gas analysers of the thermal conductivity type. It also includes details of units for the supply and standardisation of the katharometer-bridge current.

Batch Weighing Equipment

A general description of the wide range of Magco automatic weighing equipment and gravimetric feeders is provided in an illustrated leaflet issued by The Magnetic Equipment Company Limited, Lake Works, Portchester, Hants.

Calendars

This year Edgar Allen & Company Limited, Imperial Steel Works, have returned to the practice of a previous year and show a series of six paintings of Derbyshire by Mr. Martin Davenport. Short descriptions accompany each view.

British Thomson-Houston Company Limited, Rugby, have once again issued their monthly tear off calendar of landscape photographs taken by their employees and from Mavor & Coulson Limited, Bridgeton, Glasgow, a striking colour photograph of Gruinard Bay, Wester Ross.

Other calendars have been received from Brook Motors Limited, Huddersfield; Chloride Batteries Limited, Manchester; CIBA (A.R.L.) Limited, Cambridge; Fischer Bearings Company Limited, Wolverhampton; Le Bas Tube Company Limited, Bedford and General Electric Company Limited, Kingsway, London WC2.

New Factories

North Shields. Torday Limited, electroplating engineers. Factory extensions to be carried out by North-Eastern Trading Estates Limited, West Chirton..

Stanley (Co. Durham). Mr. G. Willis, Front Street, Tudhoe, proposes light industrial developments at Oxhill. Plans are by Turnbull & Son, Station Road, Chester-le-Street, Co. Durham.

Stockton-on-Tees. North-Eastern Electricity Board has let the contract for the erection of new premises in Boathouse Lane to C. Tennet (Builders) Limited, Church Road, Stockton. The architects are Couves and Partners, Grainger Chambers, Hood Street, Newcastle upon Tyne.

Sunderland. Steel & Company Limited, engineers, Crown Works, have obtained tenders for the erection of a new factory for the making of heat exchangers and pressure vessels.

Whickham (Co. Durham). Tyneside Light Alloys Limited. Plans have been approved for a 4,000 sq ft extension to pattern shop.

(Continued on page 96)

Rawlbolt charts showing full range of sizes and types with illustrated literature available on receipt of letter-heading or business card.

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You never need to improvise with Rawlbolts. There are types exactly right for every bolt-fixing job, No. 5, for example, for the support of pipe-work, and No. 2 for use with Pipe-hangers and other gas fittings. Hook and Eye Rawlbolts (Nos. 3 and 6) have many uses, such as providing anchorage for guy ropes and cables, supporting suspended ceilings, etc. There's the Loose Bolt Rawlbolt (No. 1), inserted after the machine is slid into position, and the Bolt Projecting Type (No. 4), ideal for wall-fixings.

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Birtley (Co. Durham). Ilford Limited, Essex, are planning the erection of a photographic building at Birtley.

Carlisle. Cavaghan and Gray Limited, bacon manufacturers. Plans for factory extension in London Road, prepared by Johnston and Wright, 13 Castle Street.

Carr and Company, biscuit manufacturers. Plans for factory extension at Caldcotes prepared by Huckle and Durkin, Queen Anne Street, London, W1.

Durham. Wood & Watson Limited, mineral water manufacturers, Gilesgate, Durham. Plans for factory extensions are being prepared by Page, Son & Hill, 75 King Street, South Shields.

Gateshead. The National Coal Board are to build an office block on the Team Valley trading estate. The Board's architects' department is at 24 The Side, Newcastle upon Tyne.

Houghton-le-Spring. Bursgreen Limited, woodworking machinists. The builders for factory additions are William Norman Limited, West Lane, Chester-le-Street.

Middlesbrough. British Railways, York, are to build three-storey offices in Middlesbrough railway station yard. The offices will accommodate more than 200 people.

Morpeth. Messrs. J. and J. W. Hall Limited, public works contractors, Widdrington Garage, have bought seven acres of land at the old Clifton mine for the erection of workshops and offices.

Newcastle upon Tyne. Hindhaughs Limited. Plans have been approved for extending mill, warehouse and loading dock in Pitt Street. The architect is C. S. Errington, 46 Grainger Street, Newcastle.

Elswick Bakery are to convert a former school in Denton Road and Lister Street into a bakery, to plans by Fennell and Baddiley, Bridge End Chambers, Chester-le-Street.

North Shields. Dukes and Markus, Limited, gown manufacturers. A 7,000 sq ft extension to their factory on the West Chirton trading estate is planned by North-Eastern Trading Estates, Limited.

Sunderland. George Clark and the North-Eastern Marine Limited. Plans have been approved for a joiners' shop at the Southwick Engine Works. The builders are R. E. Coleman Limited, Western Hill, Durham.

Tynemouth. Thames Board Mills Limited, London, are negotiating for a site of 100 acres on the North Shields-Wallsend boundary for the erection of a £4,000,000 papermaking factory. It is understood that other suitable sites on Tyneside are also being considered for the project.

Plastics Engraving Company Limited. Plans for converting a former Salvation Army hall into a factory are being prepared by Stephenson, Gillis & Partners, North Street, Newcastle upon Tyne.

Whitehaven. Solway Chemicals Limited, are to extend their works to increase the output of sulphuric acid and cement.

Acton. Keeler Optical Products Limited, 39 Wigmore Street, London W1. Extensions to be made to the factory at Holland House, Beconsfield Road.

Belfast. Associated Food Manufacturers Limited, are to erect a new factory on a 6½ acre site at York Road.

Birmingham. W. Ashton & Son Limited, 42 Bissell Street. New factory.

Bletchley. Drabble Construction Company Limited, Vicarage Road have received the contract for the erection of the third extension to No. 1 factory on the industrial estate.

Brighouse. R. Southern & Company Limited, are to rebuild and extend their Robin Hood Works in Wakefield Road after being burnt down.

Bury. Henry Hargreaves & Sons Limited, Cook Street, are to build a new factory near Chamber Hall.

Cheadle, Ches. J. G. Naylor & Company Limited, Woodley Mill, Woodley. A new factory is to be built at Councillor Lane.

Colwyn Bay. Quinton Hazell Limited. A new factory is to be erected at Mochdre.

Congleton. Royle Knitting Mills, Mill Street. New works to be erected in Townsend Road.

Croydon. Agrut Printing Company Limited, Grenaby Road. Extensions are to be made to the printing works.

Dagenham. J. Gasman Bros. Limited, Selinas Lane. Extensions to factory.

Dunmurry. A number of small factories are to be built on the industrial estate for the Ministry of Commerce.

New Factories

Eccles. Goldstone Limited, Frederick Street, Pendleton. Extensions to the works in Wood Street. Pendleton & Dickinson, 16 Brazennose Street, Manchester 2, are the architects.

Enfield. Murex Welding Processes Limited, Hertford Road, Waltham Cross, are to erect a new factory. The architects are Scherrer & Hicks, 27 Harcourt House, Cavendish Square, London, W1.

Greenwich. William Hughes & Son Limited, 74 Bonner Street, London, E2. New factory at Old Woolwich Road. Charles Living & Son, 233 Leytonstone Road, Stratford, London, E15, are the architects.

The Thames Metal Company Limited, Kirkland Place, are considering making extensions to their works.

Guildford. Durable Plastics Limited, Industrial Estate, are to extend their factory at Woodbridge Meadows.

Hatfield. Chrome-Alloying Company Limited, Birchwood Industrial Estate. Extensions to works. The architects are Shaw & Lloyd, 74 Great Russell Street, London, WC1.

Hereford. Denco Engineering Services Limited, Holmer Road. Factory extensions.

Hull. Kingston Lamp Company Limited, New Cleveland Street. New workshop and offices.

Kings Lynn. Beulahs (Kings Lynn) Canners Limited., The Docks. Plans have been approved for extensions to the factory.

London. Hilger & Watts Limited, 123 Camberwell Road, London, SE5. Extensions are to be made to the works at St. Pancras Way, London, NW1. The architect is F. J. Smith, 48 London Wall, London, EC2.

Loughborough. Johnson & Son, (Loughborough) Limited, Trinity Street. Extensions are to be made to the factory in Wellington Street.

Lytham–St. Annes. James Sadler (Engineering) Limited, Dock Road, Lytham. Works extensions.

Maidstone. Foster Clark Limited, Hart Street, propose to erect a new workshop.

Manchester. Ferranti Limited, Hollinwood Works, Failsworth are to erect experimental buildings at Shadow Moss Road, Woodhouse Park, Wythenshawe. The architects are Cruikshank & Seward, 196 Deansgate.

Mansfield. Janfrey (Mansfield) Limited, Thoresby Street. Factory extensions.

Peterborough. F. W. Wheatley (Trailers) Limited. Extensions are to be made to the factory in Padholme Road.

Portsmouth. The Metal Box Company Limited, Baker Street, London, W1. Extensions to the works at Burrfields Road, Copnor. A. E. Cogswell & Son, 25 Prudential Buildings are the architects.

Rainham. A. C. Dickenson & Company have received permission to erect a new factory in Lambs Lane.

Reading. Taylors (Reading) Limited, Cardiff Road, are to build a new factory.

Romford. Pagan Limited, Harold Hill. Extensions to the works in Garington Avenue. G. Shenstone & Partners, 34 Bloomsbury Way are the architects.

Sheffield. Joseph Gillott & Son Limited, Hercules Works, Herries Road South are considering extensions to their works.

Shifnal. Farmer Bros. are to extend their Aston Street Works.

St. Pauls Cray. Cray Alloys Limited, Cray Works. Leesons Hill. Extensions to works.

Watford. Cayson Electric Limited, 139 Queens Road are negotiating for a site on the Holywell Estate for a new factory.

Wednesbury. Jacon Properties Limited. Plans have been approved for the erection of a new factory at Holyhead Road Industrial Estate.

West Bromwich. Roway Motors Limited, Brandon Way. Extensions are to be made to the factory.

Edinburgh. North British Distillery Company Limited is to erect new grain storage and handling facilities at Wheatfield Road, Edinburgh, costing £6000.

William Younger and Company Limited, Edinburgh brewers have been granted authority for the erection of a pure yeast plant at Wheatfield Road, Edinburgh, at a cost of £6000.

Greenock. William Jacks & Company Limited have acquired the patents and assets of the Tubes Division of John S. Thomson and Sons, Greenock, and is planning a new factory for the manufacture of these units in Dalrymple Street, Greenock.

Inverness. Celotex is planning a factory to produce timber products.

Glasgow. James Scott & Company (Electrical Engineers) Limited have opened a new electronic equipment factory in the Carntyne estate for batch production instruments and electronic gear.

Kirkintilloch. Archibald Low and Sons Limited, Merkland Street, Partick, Glasgow, ship's engineers, plumbers and metal-workers. The new factory will be constructed by Fleming Brothers (Structural Engineers) Limited, Glasgow.

Leith. Leith Nautical College is to be re-equipped on the engineering side at a cost of £21,200. Main attention is to re-equipping of the steam engineering facilities.

Paisley. William Grant and Sons Limited, distillers, have acquired the Blacklandmill factory at Paisley for conversion into a distillery, with bottling and blending plant, and bonded stores. This is the second distillery project for Paisley.

Perthshire. John Rollo, engineer of Bonnybridge, has opened a small factory at Kinloch Rannoch in the Perthshire Highlands, to manufacture Di-atom, a car polish produced from diatomite, mined in Skye. The plant is a small one but will be developed steadily as demand expands.

CLASSIFIED ADVERTISEMENTS

Classified advertisements are inserted at the rate of 2/9 per line.

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Patents for Sale or License

THE proprietors of Patent No. 613055 for "Improvements in or relating to Methods of Infolding and Machines therefor", desire to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of Patent No. 657086 for "Improvements in Grinding Machines", desires to secure commercial exploitation by license or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London WC2.

THE proprietor of British Patent No. 682213, entitled "Forming Roll Machine", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 737352, entitled "Cable Spool Winding", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 657949, entitled "Flareless Tube Coupling", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 14 E. Jackson Blvd., Chicago 4, Illinois, U.S.A.

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